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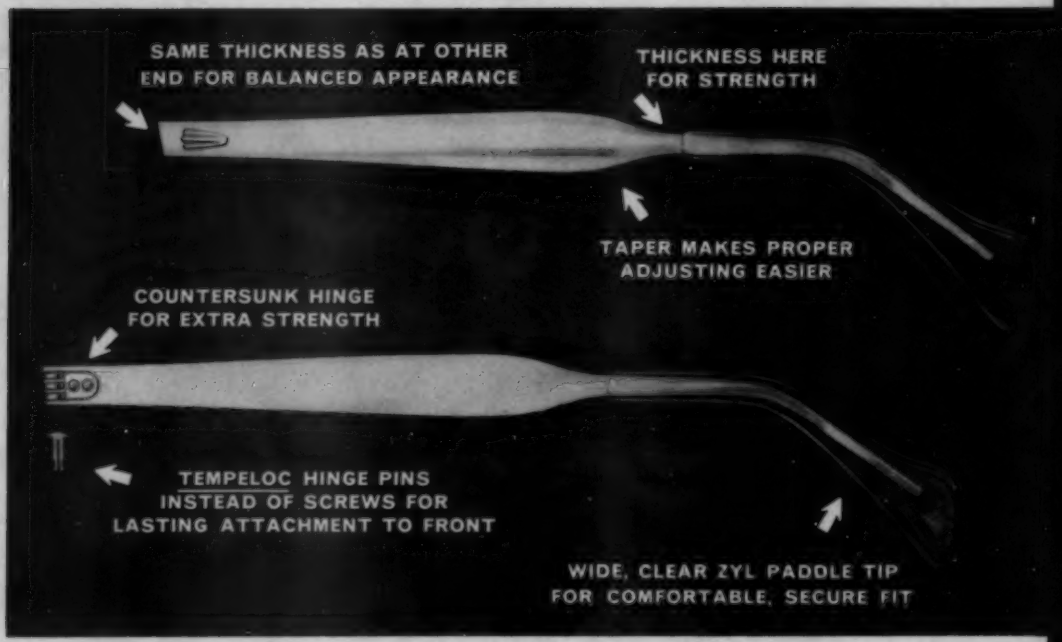
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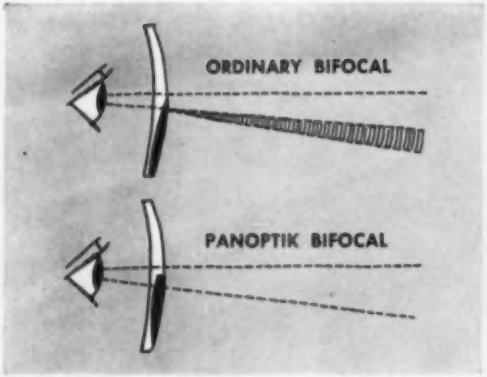

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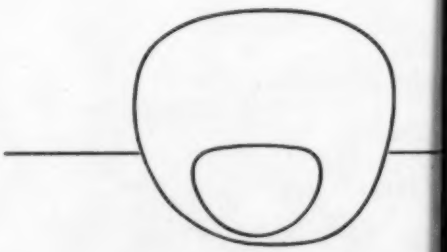

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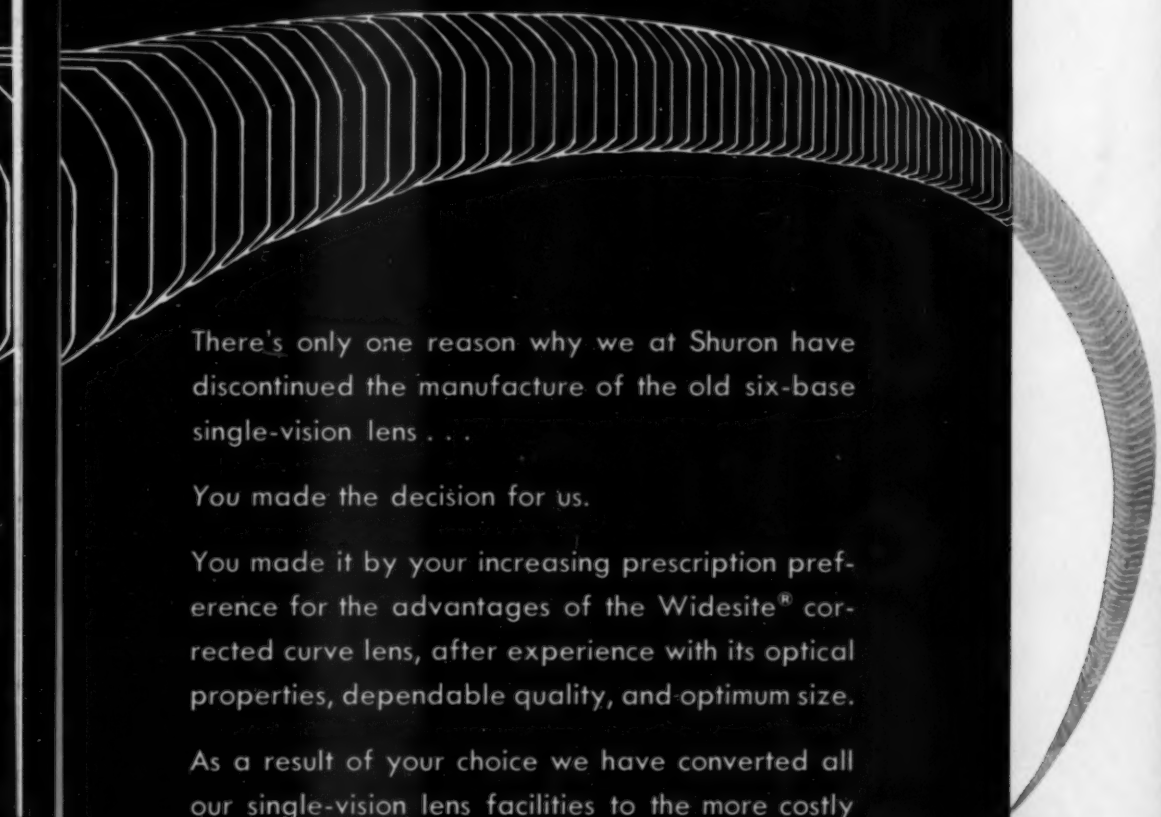

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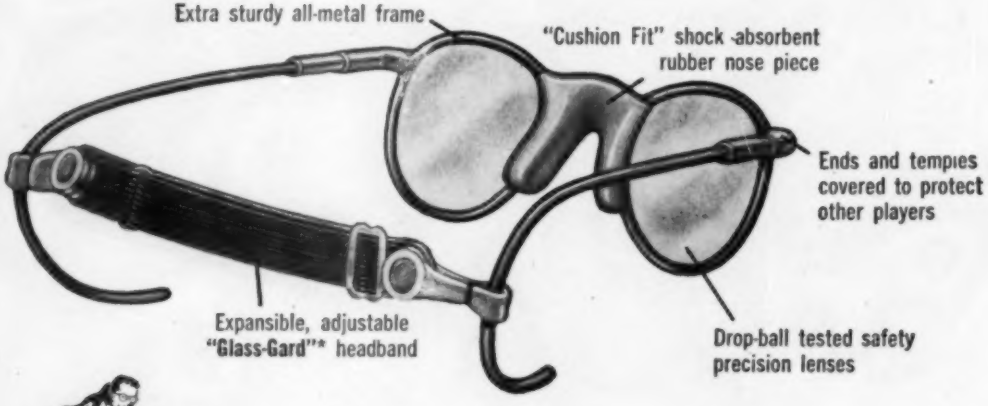
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AMERICAN JOURNAL OF OPTOMETRY
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RELATIONSHIP OF READING TYPES TO UNCORRECTABLE LOWERED VISUAL ACUITY*

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In spite of our extensive research with letter forms, few workers have attempted to investigate the importance of word pictures and the way these are accepted by persons with sub-normal vision. This may be because of the complexity of the subject, or because it has been felt that the best approach towards helping these people is through magnifying devices. As encouraging as the results in this last field have been, there is no mechanical device which is likely to be acceptable to a person if more legible print can be found.

This paper reveals what can be achieved in making an already existing type face more legible without the outlay of any considerable finance. If an existing type fount can be used,** it is possible that the knowledge available may be used, and as a first step in the direction of discovering if this is so, and of making it available to those who may need it, an approach will be made to those who specialize in printing the Bible. Not only is this book printed in larger numbers than any other, but it is more widely distributed, and can therefore reach more people with sub-normal vision.

When experimenting with lower-case letters, the first fact which becomes obvious is that unless they are arranged into familiar words, observers find them much more difficult to recognize than upper-case letters. So far as is known, only a few tests for readability thresholds, and for comparative letter acuity have been made for lower-case letters. The standard subtense of minutes of arc to the eye has been ignored, and we find that letters vary in width to height, and the 20% relationship of limb thickness to letter width is not adhered to.

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**Gil Sans Serif has been found suitable since writing this.

During the course of these experiments to be reported, we found that grouped lower-case letters become more difficult to recognize when divorced from sensible word arrangements. But the visibility of any letter varies considerably with its position in a group. To give an instance, the letter "b" is less visible in the center of a five letter group than it is at the end of the group. Some letters are even more visible at one end of a group that at the other.

It has proved to be valueless, therefore, to produce a set of threshold readings which can be translated into letter sizes so that every letter will be equally legible when viewed singly and independently, or with wide spaces between them as in a sight-testing chart, because as soon as the letters are combined into words, the individual values all change.

METHODS OF THRESHOLD MEASUREMENT

The measurement of individual letter thresholds of upper-case letters has been attempted by others as well as myself, and the technique which I used, and which was reported in Texas Reports on Biology & Medicine in 1954, was deemed adequate for assessing the visual thresholds of lower-case letters also. The apparatus used consisted of a fifteen foot track on which ran a mobile internally illuminated chart, placed at a minimum distance of fifteen feet from the observer. A remote control to move the chart either forward or backward was held by the observer, who was fitted with a 3 mm. artificial pupil. Starting from the most distant position (30 feet), he would bring the chart forward at six feet a minute until the letter on the chart became visible, and the distance from his eyes was then recorded.

When letters were observed in groups, the chart was halted as soon as one letter became visible, and when this distance had been recorded, the chart was moved forward again until another letter became visible. This procedure was repeated until all the letters in the group had been identified. Although a set of threshold values can be established for one particular type face in this way, these findings will not apply even remotely to most other type faces.

A LETTER STYLE IS DESIGNED

A type face was designed, therefore, to be used specifically for the experiments to be described here. The letters were made without serifs, plain and uncomplicated in pattern, and capable of close positioning. Two sets were made, both with the body heights subtending 5′ arc at the eye at a specified distance, the size not including tails, but whereas one set subtended the same angle from its width, the other set subtended an angle of 4′ arc from the width. The points of union of the limbs

were tapered slightly to reduce the area of black, and the limbs of all the letters had a width subtending 1′ arc at the eye.

LEGIBILITY THRESHOLDS

The relative thresholds of these two sets of letters were established on the track previously mentioned, and then the experiment was repeated exposing the letters for 7 second periods with 3 second rest periods between exposures. During the 3 second rest periods, the target was moved towards the observer a distance of 3 inches. After the thresholds of all the letters had been measured a number of times, the pattern of presentation was changed, and instead of viewing them singly, they were viewed in groups of four, the letters being arranged without intelligible meaning. In this part of the experiment it was found that grouping letters always reduced their thresholds. They were much more difficult to recognize among other letters than when seen singly.

In the two sets of letters having two different widths, the order of visibility differed, just as noticeably as they differed from upper-case letters, and just as their threshold values differed from each other. Quite obviously this situation is related to their shapes rather than their individual familiarity, for the vowels are all familiar letters, and yet their thresholds are mostly lower than those of "g" and "j," both of which are encountered much less in print than are the vowels.

A third method was used to measure the order of visibility and the relative thresholds in which the observer had no control over the movement of the chart. It was moved by the operator or supervisor during the 3 second period in which it was not illuminated. When this method was used, the threshold readings were all higher than found with the previously described methods, but there was no noticeable change in the order of visibility, so no important conclusions could be drawn from the findings.

It must be remembered in this connection that the term "higher threshold" is not used in the same manner as for visual receptors. Specifically, it means in the experiments outlined here, that letters with the highest thresholds are those which can be read at the greatest distances, and these letters are therefore more legible at a given distance, or may be made smaller than others at a fixed distance, and still be seen with the same standard of acuity.

In this method there is no specific device for defining the levels of actual seeing as opposed to guessing. It is possible that guessing is more difficult, however, when measuring thresholds, than when using purely mechanical or "calling" methods for recording vision, but this needed to be verified.

The experiment was therefore repeated on apparatus designed specifically for the limited exposure and "calling" technique with which it is possible to define the level of "probability of seeing," and of "guessing." This consisted of apparatus which reveals mechanically one letter or word for a period of seven seconds, and then while the letter is concealed for three seconds, another takes its place, and so on.

The subjects used were all emmetropic, but they were fitted with pseudo-errors of both spherical and cylindrical form. When working with individual lower-case letters, it was found that those which subtend an angle at the eye of 5′ arc both vertically and horizontally are most adequate for easy recognition. When these letters are grouped together, however, some of the letters become more visible when the horizontal dimension is reduced to 4′ of arc.

LEGIBILITY OF LETTERS IN GROUPS

As the grouping of letters has such a marked effect on their legibility, the actual position in the group must also be involved in the degree of legibility, and the experiments were carried further to ascertain this. It was found that the initial position of a letter in a group is the most advantageous for legibility, the final position being the second clearest position. Perhaps it can be said that a grouped letter is most legible when it is at the end of the group towards which an opening in the letter points, or against which its vertical limb lies, i.e., letters which are best at the beginning of a word or group are a, b, h, j, p, all of which have their opening or vertical line to the left. Letters which are best at the end of a group are c, d, e, f, k, g, s, t, most of which can be said to have an opening or line to the right.

It is probable that any effort to make lower-case letters equally visible, even if this were possible when they are grouped together into words, would be undesirable for the following reasons. If printed material being read by a person is just a little too small for his comfortable threshold, and not all letters are visible, he might still find the sense of the reading from those few letters he does see. For instance, if three letters of a five-letter word can be seen, memory and familiarity will usually fill in the other two letters and produce the necessary mental interpretation of a word. In fact there is reason to believe that some people even function in this manner, their speed of scanning picking out only essential parts of words to give them the whole word.

If all letters were provided with equal legibility, this habit might be reduced to confusion, for it would demand that every letter in a word reach the threshold of visibility at the same time, and so the threshold of the word would be infinitely more critical. Reading distance would

need to be more carefully judged and adhered to, and refractive corrections precisely and more frequently determined. Reading, therefore, could conceivably be more difficult than it now is for a large number of people.

SIGNIFICANCE OF INTER-LETTER SPACING

It seemed logical, too, to ascertain if the sizes of the spaces between grouped letters are important in their legibility, either in unfamiliar groups, or in words. The average reduction in visibility of letters by grouping is more than 12%, so it is obvious that closeness might be a factor in this reduction, and that there is a certain ratio of print per square inch of paper that must not be exceeded if reading is to be comfortable and speedy, a ratio which, of course, may vary with individuals.

There are two very consistent statements made by patients presenting themselves for an eye examination. One is, "The lines of print run together when I read," and the other is "The letters run together when I read."

These two conditions are often considered by the examiner to mean the same thing, but they probably are not, because an astigmatic error with its axis vertical makes the letters spread into each other, while one with the axis horizontal spreads the lines towards each other. See Figure 1. The obvious conclusion from this is that print with greater leading (distance between the lines), and print with wider spacing between the letters will provide greater reading efficiency to people with this kind of error, and perhaps to emmetropic or corrected subjects as well.

OBSERVATIONS ON WORDS

When observations were made on words with different widths of space between the letters, and their thresholds measured by the "approach" method outlined earlier, data resulted which showed that the distance at which a word first became visible varied greatly with the closeness of the letters to each other, and this was to some extent correlated also with the familiarity of the word.

Words consisting of letters subtending an angle at the eye of 5′ arc vertically and 4′ arc horizontally were found in most instances to have a visibility peak when the spaces between the letters were 5′ to 7.5′ arc wide. But unfamiliar words sometimes required spaces wider than 7.5′ arc to give them their maximum visibility, and almost all words rapidly lost visibility as the spaces were increased in size beyond the peak point. This was especially so with familiar words in common usage, and it suggests that technical printing, or that which is of an unfamiliar nature should be produced with wider inter-letter spacing for maximum reading efficiency. However, this inference is drawn on indi-

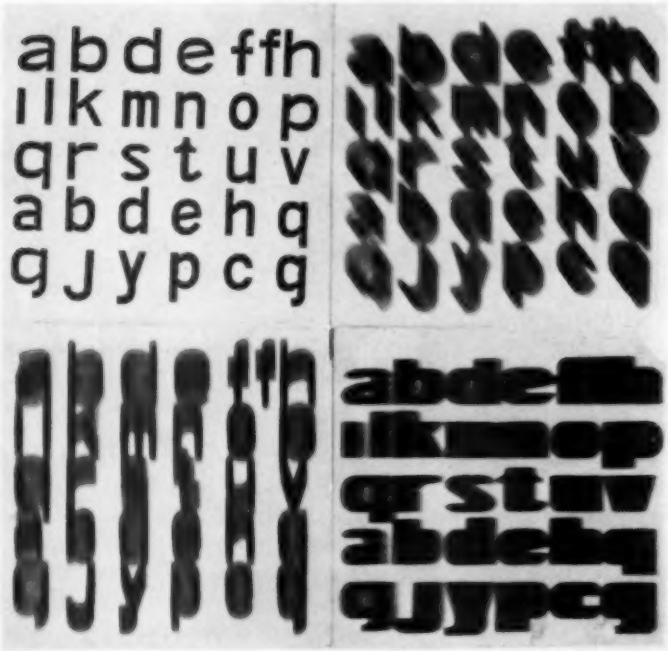

Fig. 1. Upper left. The appearance of lower case letters when viewed by an emmetropic subject. Upper right, an astigmatic subject, axis 45 degrees. Lower left, an astigmatic subject, axis 180 degrees. Lower right, an astigmatic subject, axis 90 degrees.

vidual words only, and not on sentences or paragraphs, which are the subject of a separate set of observations. Furthermore, most of these space sizes are impracticable for ordinary printing.

This set of observations was carried a step further by using sets of words which incorporated the same letters in different orders, and which are all familiar words, such as "spot," "tops," "pots." These words were arranged with variable spaces from 2.5′ arc to 40′ arc, each word having the full range of spacings. Here again, it was found that increased width of spacing reached a point beyond which it could not be carried without a decrease in legibility, except in words which have to be spelled out letter by letter.

Using words which contain the same letters in different orders produced a situation in which the two main variables are the order of the letters and the familiarity of the words to the observers. This

showed that non-physical factors, which do not exist when letters only are read, play an important part in the reading of complete words. Besides memory, familiarity, intelligence and perceptive interpretation, certain psychological elements of association seem to play a part in the recognition of some words.

APPLICATION OF RESULTS ON WORDS TO READING

Obviously, all these observations and the resultant findings are of little use unless they can be applied to actual reading ability, and this had to be the next step in the investigation, the factors to be examined in a normal reading situation being:

1. The size of spaces between the letters of words.
2. The familiarity or lack of familiarity of the reading material, (its simplicity).
3. The background or profession of the reader.
4. The age of the reader.
5. The I.Q. of the reader.

So six tests were devised, each consisting of a paragraph of 53 words which were presented to one hundred readers chosen from volunteers in various age and occupation groups within the university.

Test No. 1 consisted of words with conventional spacing, and very difficult reading material.

Test No. 2 consisted of equally difficult reading material, but the spaces between the letters of the words were increased to 4′ arc.

Test No. 3 was similar to test No. 1, except that the length of the lines was increased by 100%.

Test No. 4 consisted of ordinary simple reading material and conventional spacing between the letters.

Test No. 5 was the same as test No. 4, except that the spaces between the letters were increased to 4′ arc.

Test No. 6 was the same as test No. 5, except that the length of the lines was increased 100%.

When the reading speeds for these six paragraphs are examined, they seem to carry little significance except that simpler print is read more easily than is difficult print, and that wider spacing is only beneficial to reading speed when the printed matter is of a difficult nature, both of which facts could have been anticipated anyway. But if the data are broken down further into groups by age, profession, I.Q. and sex, it assumes much more significance, and this will be analyzed before the final part of the investigation is discussed. The average age of the 100 observers was 29.74 years, the youngest being 17 and the oldest 65. Occupations were divided into three categories: faculty, students, and

clerical staff; the subjects were also divided into three groups by I.Q., over 120, under 120, and unknown. All groups were also divided into male and female, and also broken down into age groups as follows: 15-25, 26-35, 36-50, over 50.

PROBABLE INFLUENCE OF AGE ON READING SPEED

The findings of this test suggest that age influences the speed of reading. The highest efficiency appeared to be attained in the 26 to 35 year old group. This may be the period when learned processes are most intensively applied, while after this, mental processes and muscular innervations may begin to be retarded. In the lowest age group, the slower reading speed may be related to the incompleted learning process. Probable error leaves the difference between the first two age groups in the region of insignificance, but in the two highest age groups, the reading speed diminishes to such an extent that there is no doubt of the influence of age on reading speed.

It is obvious that the data available from the subjects of these tests relating to their I.Q. is far from adequate to suggest any trends. Most subjects either did not know their I.Q. rating or preferred not to reveal it, and only 34% of them gave an actual figure. All that can be said is that subjects with an I.Q. below 120 read both conventional and difficult prints somewhat faster than did those with an I.Q. over 120, while those subjects who did not reveal their I.Q. demonstrated a much slower reading speed than the "under 120" group to the extent of 26% and 21.6% slower than the "over 120" group.

It is possible that subjects with a higher I.Q. may devote more time to the practical application of what they have learned, and less time to light reading. Also, what reading they do may normally be of a kind which requires more concentration, and therefore a slower habit. There may also be an undisclosed relationship between reading aloud and reading mentally. Many subjects with a high I.Q. appear to scan (rather than use their customary reading pattern) when compelled to read aloud as these subjects were.

When all the observers were divided into profession groups, the best readers appeared to be the faculty members, students being second, and clerical staff third in order of efficiency. But the simplicity of this placing is deceptive, for the average of the clerical staff was placed in the older groups which are the slower readers anyway, while the average age of faculty was within the peak reading speed period.

When the data are broken down still further, one or two interesting things reveal themselves. When test Nos. 1 and 2 are compared, that is standard spaced difficult print, and widely spaced difficult print, No. 2 is

found to be better for the clerical staff average, for all the averages under I.Q. headings, and for all averages of subjects over 36 years of age.

This last group is interesting when considered in relation to the lowest age group which reads No. 1 test better than No. 2, and the 26 to 35 year old group which makes an average identical time for both tests. It suggests that wider spacing has definite advantages for older people, but might even have disadvantages for younger readers. At first this looks as though age may be the important factor, but it is probably reading distance, *the young reading closer than the old*, and, therefore obtaining an *enlarged retinal image* of both print and spacing. This was a factor visualized constantly when devising the final tests to be described later.

Tests Nos. 4 and 5 were of normal everyday reading, but with conventional and wide spacing respectively, and it is interesting to find that the average reading time for those in the group showing an I.Q. above 120 is lower for the wide spacing than for the narrow, while the average time for those in the age group over 50 shows that the wider spacing is preferable for them. This is probably related to reading distance once again.

Test No. 6 was of normal reading with wide spacing and a wide column. This strangely enough gave the best average time for students whose I.Q. was under 120, and for the age group over 50. In the group with I.Q. over 120 it equalled the best time (No. 4).

CONCLUSIONS OF THIS TEST

Analysis of all these observations suggests that an *increase in the width of spaces* between the letters of words has advantages only if the print is of complex or *technical wording*, and then only in *older people* or those in the *lower education* brackets. It has greater advantages, however, when combined with *longer length of line*, and this may be because wider spacing produces fewer words to a line, and therefore more excursions of the eyes for a standard amount of print. But this length of line was less critical in conventional wording.

All the findings discussed so far were on emmetropic or corrected observers, and it is obvious that they do not constitute a complete set of observations unless they are repeated under varying conditions of ametropia. So this was done with both single words and paragraphs of reading, with at least two different widths of spacing.

First, four sets, each of four words, were designed into the apparatus used for observations by calling, each set being repeated with a different inter-letter space size. The words in each set were of interchanged letters, and were as follows:

Set 1. Pear, pare, reap, rape.
Set 2. Post, stop, spot, pots.
Set 3. Mate, team, tame, meat.
Set 4. Live, evil, vile, veil.

These words were made with letters which when used at the designed distance were equivalent to chart letters of 20/15, 20/20, 20/25, 20/30, 20/35, and 20/40, and they were exposed for observation with conditions of artificial ametropia, both spherical and astigmatic, with the axes at 90°, 180°, 45°, and 135°.

The highest scores were obtained when observing these words with the axis of artificial astigmatism at 180°; that is when the effectiveness of the refractive error was in the vertical meridian and any image spread was *not* from letter to letter over the width of the word. When the axis was 90°, however, the image spread was in a horizontal direction and visual separation of the letters became much more difficult. The actual percentages of correct calls with 2′ arc letter spaces was 99.5% for axis 180°, 76.1% for axis 90°, and for axis 45° and 135° the percentages were much lower than this. The percentages were arrived at by combining all powers up to 2 diopters at a given axis, and plotting the number of correct responses against the number of presentations on the ordinate, and the letter sizes on the abscissa.

If the two axes 180° and 90° are combined, the percentage of correct calls then becomes 87.8%, while if the axes 45° and 135° are combined, the percentage of correct calls is 67.9%, a 20% difference. Apart from the photographic evidence supplied, this is an indication of the reduction in vision experienced by individuals with astigmatism at oblique axes.

The high scores quoted in the last paragraph are surprising since degrees of myopic astigmatism up to 2 diopters are involved, but the graphs illustrating the scores show that nothing like this high percentage is possible with print that is spaced conventionally. And the more narrowly spaced letters prove to be much more critical in their visibility rating. This can be seen in the curves which rise steeply from horizontal plateaus.

The inference from the data obtained is that words with wider spaces between their letters will be more clearly visible to people with a wider variety of, and higher degrees of visual error than words with conventional spacing. What is more important is that these more widely spaced words will be more legible to people with uncorrectable subnormal vision. A subject with maximum vision of 20/40 will be able to see the same print as a person with 20/20 vision if the spaces be-

tween the letters are twice the width of those viewed by the person with 20/20 vision.

The actual spaces between the letters (which were mostly 4′ arc wide and 5′ arc high) were 2′ arc in the widely spaced word, and 1′ arc in the conventionally spaced ones. Another factor which may have been of some importance in this print is that the spaces were the same between every letter, something which is not normally encountered in typesetting.

SPACING OF PRINT IN ORDINARY READING

It was felt that these results, found on single words only, might not have so much significance when compared with similar findings on whole sentences where many more variables apply, and so a further experiment was designed to incorporate sentences and even paragraphs of type with different widths of spacing, but in this test it is obvious that point of threshold or scoring of correct answers would be impracticable, and this would again have to be substituted with something like a speed of reading test with paragraphs of exactly equal leng:h and simplicity of wording, but different spacing, just as was recorded earlier, but with a greater control of the variables involved.

So two equal paragraphs of normal reading material were designed, the first with 1′ arc spacing between the letters, and the second with 2′ arc spaces. These were mounted at a distance of 125 cms., from which point the main bodies of the letters would subtend a vertical angle of 5′ arc at the eye. See Figure 2. A maximum of 0.8 diopters of accommodation would be demanded of an emmetrope or a corrected ametrope, and the speed of reading of these paragraphs was timed to 1/10 second with a stop watch.

From here on, the experiment was divided into two parts, not all of which are yet completed. Part one used subjects chosen in the university, who, as well as being emmetropic or corrected, were between the ages of 20 and 35 years. The reading was performed under conditions of unvarying illumination and controlled distance, and performed under emmetropic and pseudo-myopic and astigmatic conditions at various axes, and with 3 mm. artificial pupils.

The second part of the experiment entailed devoting the data compiled in the first part, to finding to what extent subjects could be used when they possessed uncorrectable low visual acuity, the idea being to evolve gradually a print and a letter spacing technique which can be used on subjects with sub-normal vision.

It was realized at the same time that although it is convenient to assume that the spread of print in any particular direction is due to

Birds are the best known and most easily recognized of all animals, because they are easily seen, are common, and are active by day. All birds have feathers that clothe and insulate their bodies to make regulated body temperature possible, and those of the wings and tail provide flight. No other animals possess feathers. The ability to fly enables birds to occupy some habitats denied to other animals, and to move about actively.

The habits of birds are known in great detail through studies by many professional and amateur students. The distinctive coloration and voices of birds appeal to human eyes and ears, and many bird species are of economic importance because of their food habits. Certain kinds are hunted as game, and the few domesticated species contribute to man's food supply. The ancient classical names for birds are perpetuated in the name of the class.

Fig. 2. Top. 1′ arc spacing between the letters. Bottom. 2′ spacing between the letters. Equal paragraphs of print with different inter-letter spacings designed for the second speed-of-reading test.

an astigmatic error in the subject's eyes, there might also be other elements, perhaps purely psychological to account for this, or at least for part of it. It had already been found that when making observations with Landolt rings, an axis of 135° produced a different level of scoring from an axis of 45° in an emmetropic subject. One can accept that this might be possible between the axes of 180° and 90°, but theoretically the former two axes should give similar scores.

So another experiment was conducted in which the scoring was based on the separability of two concentric circles, made to coincide in size with Landolt rings normally used for such tests. The subjects were once again given pseudo-myopic astigmatic additions, and these were placed at the four different axes, 180°, 90°, 45°, and 135°. In theory, differentiation of the circles should be equally possible at any axis because of the absence of breaks in them. Only the direction of blur should change, but the space between them should be visible along the axis of the error. This is exactly what happens when these circles are photographed by a camera fitted with astimatic lenses.

In practice with subjects, however, the scoring was by no means uniform, the order of preference for axes being 135°, 180°, 45°, and 90°. This was slightly different from the scoring in Landolt rings by the same subjects, the order for those being 135°, 180°, 90°, and 45°, but near enough to warrant the inclusion of data from other observers. So an average was taken of the observations made on Landolt rings by three reliable observers, and in this instance the order of preference was 135°, 45°, 90°, and 180°. All that can be said from this is that there appears to be no doubt that myopic astigmatism at axis 135° permits better vision than any of the other three axes, and that a large section of the population would need to be included in the survey before it could be ascertained if there is or is not a psychological element which obviates the known laws of optics in the recognition of patterns, as appears to be the case in these experiments.

A further check with a checker-shaped form having no relationship to rings or letters was made to see if the axis preference in the Landolt rings was in any way connected with the break position and its resemblance to a letter "c." The most reliable observer was used, on whom data for the Landolt rings was already at hand, his order of preference for axes of induced myopic astigmatism being 135°, 180°, 90°, and 45°.

The new set of readings with the checker was not significantly different from those found with Landolt rings or concentric circles, the order of axis preference being 135°, 180°, 45°, and 90°, the last two being very close together.

Each of these experiments seems to verify the others, and it is, therefore, necessary to say that in *these experiments* outlined, and in the *subjects used*, there appears to be an unidentified element which provides better vision for myopic astigmatic errors at certain axes than at others, and that this is not related to the spreading of one letter or word into another. It is reasonable to suppose, therefore, that whatever this factor may be, it is in some degree responsible for the findings in the reading experiments also, but in this case the spreading of letters and words into each other is certainly involved to some considerable extent.

As the experiments in reading are not yet completed, it would be premature to cite more than trends or possible ultimate findings from those results already in hand. One thing is irrevocably established, however. Spaces of 2′ arc (or half the width of a letter "o" when this is 5′ arc high and 4′ arc wide), which are uniform between all the letters of words, improve the legibility of reading far beyond that in which conventional spacing is used, both as regards the speed at which it can

be read and the distance at which it can be read by emmetropic, myopic, and astigmatic subjects.

This improvement in legibility applies up to the moment, to all persons with all types of visual error, and therefore suggests that it will also apply to patients with subnormal vision. This part of the experiment has yet to be completed. The improvement of legibility with increased inter-letter spacing varies considerably between subjects, some experiencing as much as 150 to 200 per cent improvement, while others appear to experience as little as 10 per cent. The reason for this is not apparent, but may be related to intelligence or normal reading ability. The greatest improvements appear to be in myopes with vision of from 20/40 to 20/60, but in a number of cases in which vision was no more than 20/70, print with conventional spacing was quite beyond the capacity of the subjects to read or even define a word, whereas 2′ arc spaced print could be read slowly, i.e., at from one-third to one-quarter normal speed for the subject concerned. Some subjects could even approach the normal speed under these conditions. Performance has been found to be even better under uncontrolled conditions, in which a subject can choose his own reading position, angle of gaze, and reading distance. See Figure 3.

From this, one can deduce for further experimental verification that some subnormal vision patients with 20/70 vision can be given print of a size normally presented to persons with 20/20 vision, and

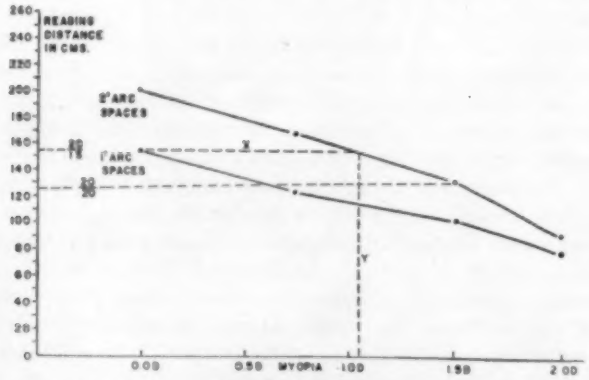

Fig. 3. The relationship between 1′ arc and 2′ arc inter-letter spaces when the criteria are reading distance and myopic error. The difference in legibility in this case enables approximately one diopter of myopia to be present when reading words with 2′ arc inter-letter spaces, to give the same result as an emmetrope would obtain with 1′ arc spaces.

by changing the letter spacing, enable him to see it. If the print is enlarged also, then it should be possible for a person with say 20/200 or 10/200 vision to read with comparative ease, and this is to be investigated in the next part of the experiment.

The statistical chart compiled from the results already obtained shows also that differences of astigmatic axis made no difference to the relative improvement in legibility obtained with the increase in word spacing. The most outstanding factor in this was the number of subjects who could not read the conventionally spaced print at all, but could read the more widely spaced print. See Figure 2. The first step in defining a standard of type for improved legibility that will assist subjects with uncorrected subnormal vision, therefore, seems to have been surmounted.

SUMMARY

This paper describes the progress made in a project in which experimental evidence has been produced to demonstrate that with scientifically planned inter-letter spacing, print that is ordinarily visible only to subjects with emmetropia, can be made legible to subjects with a certain degree of uncorrectable low visual acuity. It is intended to extend the experiments to the fields of amblyopia and uncorrectable subnormal vision. The ultimate aim is to promote the printing of books with print that will be more legible to elderly readers and those with greatly reduced vision.

ANNOUNCEMENT

A.O. COMPANY—SPECIAL LENS SERVICE

The appointment of Henry B. Wilson, O.D., as Special Lens Service Manager has been announced by American Optical Company, Southbridge, Massachusetts. The position has been created as a means of unifying under one head the responsibility for improved service on special lenses to A.O. customers and branches.

He will be responsible for establishment of a system for scheduling and expediting of special lens production and Iseikonic Rx service. He will make direct contact with customers and branches on questions of service in special lenses.

Dr. Wilson joined American Optical Company in 1956 and has served on the lens product staff since that time. He is a graduate of Massachusetts School of Optometry. During World War II he served as a navy pilot, and was in charge of the safety program at the Norfolk Navy Yard in the Korean War.

FACTORS IN CLASSROOM ILLUMINATION*

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The need for good visual environment in the classroom in the promotion of reading activities is indeed indisputable. Studies in lighting research by Guth,[7] the lighting research scientist for General Electric Company in research at Nela Park, Cleveland, Ohio, indicate that "both blinking and tenseness have been found to be attributable to poor lighting." In addition, Guth states that children may have normal eyesight when they start school, but, as they move on to the higher grades, the percentage with defective eyesight tends to increase. However, more research shows that better lighting can improve the "prolonged visual performance" of people with below standard vision and those with normal vision.[3] The significance of this help is emphasized by a report of the White House Conference on Education which shows that approximately 20 per cent of the school population has some type of visual handicap.[15]

In order to provide the classroom with a visual environment appropriate for school activities in which pupils and teachers are engaged, study and experimentation in the field of lighting is constantly providing the educator with new data, materials and suggestions. Indeed, because of the diversity and availability of a wealth of new information in this area, it has been difficult for school staffs to keep up with recent scientific developments and their particular applications to the problem of classroom illumination.[3]

Gibson[6] stated that the most significant activity of people now interested in school lighting is "constructive communication." This is defined as an activity in which people with varying interests in the same field present their points of view in a roundtable discussion. In this manner such groups as the National Council on Schoolhouse Construction, the Illumination Engineering Society, and the American Institute of Architects meet to clear up certain controversial issues by planning research projects and potential revision of certain accepted procedures. The revision of the document "American Standard Practice for School Lighting (1948)," was the decision made in a meeting held by the three national groups mentioned here.

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The foregoing would indicate that there is considerable disagreement among authorities in the field regarding lighting practices. Indeed, an examination of Illumination Engineering Society publications would reveal confusion "on certain points of common concern."[6] One major point of disagreement is that of recommended light intensities to be used in classrooms. Tinker[13] states that one cannot depend on the recommended light intensities set forth in bulletins on standard practice. In view of this, it is not difficult to understand why educators find it a difficult task to keep apace of lighting developments.

Despite certain controversial points, lighting authorities have agreed upon various goals which are general factors for measuring lighting progress and for guarding against the use of illumination devices which may be detrimental to proper illumination in the classroom. These goals are not arbitrary ones; they are, rather, based upon diverse opinions of authorities and researchers in such fields as lighting, engineering, architecture, medicine and education.[3] This set of objectives has been adopted by the National Council on Schoolhouse Construction and "follow closely the general recommendations of the Quality and Quantity Light Committee of the Illumination Engineering Society."[6]

A study of the goals of good lighting would reveal that the effectiveness of classroom illumination is determined by brightness and brightness relationships.[3] The direct brightness of light sources and the reflected brightness of all other surfaces inside and outside of the room contribute to the lighting conditions in that particular room. Thus, brightness and reflectance, and not illumination intensity alone, become important factors in the problem of school lighting.

In further study of the good goals for lighting, which are sometimes referred to as brightness goals in more technical writings, one may encounter the term, foot-lambert. This is a measure of brightness which can be determined with the use of a brightness meter or by multiplying the foot candle intensity by the reflection factor (percentage of light reflected from an object) of the object.[3]

The reference point task brightness is another term used in checking the light conditions of a room. Since it would be difficult for illumination specialists to compute brightness in terms of the reflectance factors which are dependent upon the many objects in various positions in the classroom, an area of the room which shows the lowest foot candle reading is used to establish the *reference point task brightness*.[3] This location thus becomes a reference point from which the brightnesses of other areas in the classroom are determined during the evaluation of visual conditions therein.

Moreover, to simplify matters, lighting specialists have established 70 per cent as being an average reflectance factor for the various schoolroom tasks in an actual working situation. In view of the above, it appears that the main problem in classroom illumination is the maintenance of a brightness balance between the central point or reference task brightness and the other surfaces within the total visual environment.[11] It is precisely the task of these goals to define certain criteria which would maintain this proper brightness balance.

In order to achieve illumination which follows the general recommendations of the brightness goals set forth by the Illuminating Engineering Society, the National Council on Schoolhouse Construction and other groups, consideration of the physical environment of the classroom is necessary. In brief, the maintenance of the proper brightness balance in terms of visual comfort and efficiency is dependent upon not only the proper intensity of light used in the classroom, but also the windows, walls, floors, ceilings and classroom furniture used within the lighted area.

Adams[1] states that effective illumination must be achieved by combining the brightness factor with the proper treatment of walls, ceilings, floors and other reflecting surfaces within the classroom.[21] Since the light which enters the room through such media as windows and electrical sources is reflected and distributed throughout space by the reflectance of colors, color design can thus affect good seeing conditions.[12]

The sources of light are, of course, the brightest areas in a room, thus the areas close to these should be as light in value to bring brightness contrast to a minimum.[12] In view of this, windows and wall areas where windows occur should be as high in value as is feasible. Ceilings should also be high in value and with the use of indirect lighting, the upper wall areas adjoining should produce a reflectance of at least 70 per cent.[12]

Chalk-boards and bulletin boards which take up wall space within the classroom should be of lower reflectance than the ceiling and the areas adjoining these should have a value between their reflectance factors and higher reflectances of adjacent surfaces to serve as transition.[12] In this way, color brightness contrasts, which are both tiring and distracting to the eyes, can be reduced to a minimum.

Most floor covering, in the new schools, at least, is of asphalt tile.[1] This should be as light in value as possible to reflect and diffuse light, and to eliminate as much brightness contrast as possible between the work on the desk and the desk top itself.[12] With the proper use of light asphalt tile, brightness contrast can thus be brought to a tolerable level.

Classroom furniture now available is chiefly finished in colors of high value to aid in the reduction of problems in brightness contrast.[12] This accounts for much of the blond furniture in the form of students' seats and teachers' desks one sees in the classroom. It must be remembered that although glossy surfaces are easier to clean, care should be used to avoid mirror-like reflections caused by smooth-surfaced furniture.

According to Reid,[12] a member of the American Institute of Architects' Committee on School Buildings, the obvious conclusion for a color scheme to aid proper illumination in the classroom is to make it predominantly "neutral and quiet." Accents of high-chroma colors should be reserved for small areas and their hues should be few in any one room, generally no more than three. The large areas of the room should also make use of few hues, generally not more than two, of which one should predominate in that area. In any instance, and for obvious reasons, the color scheme for a classroom should be one that produces a suitable color effect and one which will conform to recommended reflection factors, based on long-term occupancy of that classroom.

While proper illumination within a classroom is based upon several factors contributing to the visual environment therein, another factor which is most important and sometimes quite difficult to control is high brightness caused by unshielded daylight entering the room from without. Basically, the use of fused glass windows of various types or proper manipulation of window shades, which can be pulled from both bottom and top of the window space, or the use of blinds will help control such brightness. Care must be exercised with the use of blinds since improper installation may be responsible for patches of unshielded light entering the room. With the introduction of newer types of schoolroom windows which are illustrated in the professional education magazines, however, it appears that the problem of combating unshielded light which enters the classroom is gradually being solved through research.

Though daylight is the ideal light source for use in the classroom, electric lighting systems are a versatile source of light with which to work in the classroom. The use of the several types of lighting systems—incandescent, fluorescent, or any of the numerous variations should be designed to provide visual conditions which meet the recommended brightness goals previously discussed. In this way, both daylight and electric light are utilized as light sources for schools, with one supplementing the other.

Most teachers have little or no control over the provision of the

proper quantity and quality of illumination in the classroom; however, they should take advantage of the facilities available in order to help students who have poor eyesight. In view of this, recommendations may be adopted with any necessary modifications needed to fit the classroom situation.[10] These recommendations are as follows:

1. Seat pupils with poor eyesight in the best seeing locations.
2. Write large and clear on the chalk-board and use large lettering on bulletin boards.
3. Use window shades or blinds to reduce visibility of sun and bright sky which tend to create glare conditions.
4. Use number 1 soft pencil on white paper.
5. Insist on good reproduction in stencil-duplicated material which is to be passed out to students.
6. Tilt reading material upward, thus creating an angle with the desk top since the visual size of flat printed material is reduced approximately 30 per cent.[7]
7. Refer students with defective eyesight to proper authorities for eye tests and/or treatment.

Such is a study of classroom illumination. From this discussion one may conclude, first of all, that proper classroom lighting can aid those students with visual problems in their reading activities. Secondly, it must be remembered that the lighting standards that are set forth by the Illumination Engineering Society, the National Committee on Schoolhouse Construction, the American Architectural Society and the various commercial firms in the lighting industry are constantly changing due to research and developments in the field. Therefore, only the most recent lighting standards should be used by educators as guides in planning for schoolroom lighting. Thirdly, the main problem in classroom illumination is concerned with the maintenance of the proper brightness balance in all areas of the room. Fourthly, the brightness balance within a given room is dependent upon the percentage of light reflected from the various objects in the room; namely, ceilings, floors, walls and classroom furniture. Moreover, the various color combinations used on these objects also affect the percentage of light reflected. Finally, and perhaps most important of all, the teacher may make slight physical changes in seating arrangement or types of reading and writing materials used to aid those students with visual defects. Although most teachers may not be in any position to do much about lighting, they can, however, compensate for defective illumination in that way. Indeed, the teacher remains, in this case as always, a key figure in the entire educational process.

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GIFFORD ROAD

NORTH WESTPORT, MASSACHUSETTS

ANNOUNCEMENT

YELLOW BEST PROTECTIVE COLOR

Yellow rather than red is the best protective color for hunting garb, claims Dr. Donald L. Baker, president of the Long Beach Optometric Association, reporting on tests conducted October 7-12, at Fort Lewis, Washington. "According to partial tabulations, yellow was recognized six times as quickly as red, even against the brilliantly-hued reds and yellows of autumn foliage."

Using U. S. Army personnel, tests were also staged in the Wenatchee National Forest near Merritt, Washington, by the research team which included Leslie E. Lahr, California Fish and Game Department hunting safety director, and Col. E. F. (Tod) Sloan, western representative for the National Rifle Association. Speed and accuracy of identification were recorded for every color in the spectrum during morning, noon and twilight hours. Early results show the "correct" or most easily visible shade of yellow to be 577 millimichrons with 75 per cent color saturation. Washington and Oregon state game departments also had officials helping on the hunting safety research project.

THE DENIAL OF COLOR-BLINDNESS*

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It would seem apparent that those individuals who are "color blind" should be fully aware of the presence of this defect by the time they reach their early adult years. There are sufficient opportunities in primary and secondary school and in other socialization experiences during the growth of the individual to provide adequate opportunities to reveal color matching difficulties or inability to properly name the various shades of color. In the course of testing numerous individuals, however, it was found that many of those who were identified as color blind would vigorously deny the fact despite the most obvious of evidence.[1] To determine the extent of this denial of color blindness, several questions were added to a questionnaire which was administered as part of a color coding research investigation pertaining to human engineering design recommendations for complex military equipment. Specifically, the purpose of this study was to determine how many of the color blind subjects would admit that they either had "difficulty" in matching and naming colors or that they were "color blind."

PROCEDURE

The questionnaire was administered to 360 United States Army male soldiers in their 8th week of basic infantry training. This group had not been previously screened for color vision defects by military authorities. The sample, therefore, apparently constituted an unselected sample with regard to this defect. The mean age of the sample was 19.8 years (S.D. 1.4, range 17-25), the mean weight was 161.3 lbs. (S.D. 19.7, range 118-230), and the mean height was 69.5 inches (S.D. 2.6, range 61-76).

At the time they filled out the questionnaire, the examinees did not know that they were to be given a standard color perception test. Their attention was distracted from the color coding portion of the experiment because of a series of photographs of semi-nude models in various dynamic positions were shown between the completion of the

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questionnaire and the administration of the standard color perception test.

The test used was the Dvorine Pseudo-Isochromatic Plates, Second Edition. It was administered under standard conditions[1] with illumination which had a rated color temperature of 3400°K and, as indicated by measurement with a Weston Meter, a direct light intensity of 150 foot candles and a light reflection off the face of the color plates of 3.2 foot candles.

RESULTS

One out of every ten of those examined were found to be color blind (3.1% "borderline," 1.9% "moderate," and 5.6% of "severe" degree). This compares favorably with previously published standards for adult males.[2] It should be noted that, when used in this study, "color blindness" refers to any anomalous or dichromatic color vision defect which renders an individual incapable of naming or matching colors with the perfection usually demanded in everyday activities. Color perception weakness would be a better term for this visual defect but the conventional or most commonly used lay term is color blindness.

Almost all of those with normal color vision expressed no difficulty in matching or naming colors, but only 25% of those who were found to be color blind were willing to admit that they had difficulty with colors. It should be pointed out that those who were more severely handicapped were more willing to admit that they had some difficulty (42.1%). However, it is still highly significant that three out of every four of all of those found to be color blind either did not know or refused to admit that they ever had any difficulty in matching or naming colors.

When bluntly asked if they were color blind, only 18.4% of the color blind would admit that they were color blind or even slightly so. Twice as many of the color blind claimed that they "didn't know" whether they were color blind and this, perhaps, may indicate some evasiveness or uncertainty. Nevertheless, it is important that the vast majority of those who were identified as color blind actually denied that they were color blind (including 50% of all the "severe" cases).

While more of the color blind were able to admit some "difficulty" with colors as opposed to outright admission of "color blindness," the difference (7.3%) was not great. This, despite the fact that two questions (Table 1, questions 2 and 3) were inserted in the questionnaire to reduce contamination of responses pertaining to color blindness. The results of these questions, by the way, indicated that there was no marked association between color blindness and certain

disease entities which may have psychosomatic etiological components.

TABLE 1

Responses to Questionnaire

1. Have you ever had any difficulty in naming or matching colors? ($N = 351$, $P < 0.01$)

	Normal	Color Blind
yes	1.6%	25.7%
no	98.4%	74.3%

2. Are you usually: ($N = 351$)

	Normal	Color Blind
overweight	8.9%	7.9%
about average	77.0%	73.7%
underweight	14.1%	18.4%

3. Which of the following have given you trouble: (378 responses)

	Normal	Color Blind
heartburn or upset stomach	8.0%	12.8%
occasional constipation	3.8%	5.1%
high blood pressure	0.9%	0.0%
tense or nervous	16.2%	15.4%
get tired easily	15.0%	15.4%
none of the above	56.1%	51.3%

4. Are you color blind: ($N = 355$, $P < 0.01$)

	Normal	Color Blind
yes	0.0%	10.5%
only slightly	0.6%	7.9%
not at all	92.8%	65.8%
don't know	6.6%	15.8%

It is interesting to note that Chi Square evaluations of the relation between color blindness and height, weight, and age surprisingly revealed that height was significantly associated with color blindness at the 5% level of confidence. Whether taller individuals tend to be more color blind or, more likely, that they are the victims of an erroneous rejection of the null hypothesis, remains to be seen.

Therefore, it is apparent that only a small percentage of the color blind will admit that they have such a visual defect or even that they may have some difficulty in matching or naming colors. It may very well be that these individuals don't know of their defect but this is hardly likely for these reasons: (1) so few responded to this alternative which was provided in the questionnaire, (2) the ample opportunities for discovery of such a handicap in normal socialization and education of the individual, and (3) because of the character of the verbal responses of many of the examinees. Even when told of their color perception anomaly and given ample demonstration of the differences between their responses and those of their peers, in many cases there was a steadfast reluctance to admit the fact that their color perception was deviant. Perhaps further research can reveal the nature and

causal factors of the emotional tone which seems involved in what is apparently a characteristic denial of defect by the color blind.

CONCLUSIONS

The results of this study indicate that those young adult males who are identified as "color blind" by the use of a standard pseudo-isochromatic color perception test are unusually reluctant to admit that they are color blind or even that they have any difficulty in matching or naming colors. In many cases this denial of defect by the color blind subject was accompanied by strong emotional feelings of non-acceptance of such an ego-defect.

65 MANOR DRIVE
NEWARK, NEW JERSEY

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ANNOUNCEMENT

REPORT ON A.O.A. CONFERENCE ON INDUSTRIAL VISION

About seventy-five optometrists, manufacturers and safety engineers attended the First Annual Conference on Industrial Vision, sponsored by the A.O.A. Committee on Occupational Vision at the Congress Hotel, October 19 and 20, Chicago.

While uniformity was pursued, wide differences of opinion appeared, particularly at a panel session with ophthalmic manufacturers as speakers. The talks indicated that uniformity has its limitations, because practices must be adapted to the employer's needs and policies, and an optometrist may have differing relationships with two or more clients. Major points emphasized were that the industrial vision specialist must become familiar with the industries he serves and with the legal and customary requirements for safety eyewear, and he should realize that the volume of work that may come from industrial vision programs does not reduce the amount of time or cost that must be allocated to each patient. Marked geographical differences were shown in the reports from states. In northern industrial areas, optometrists seek close cooperation with unions; in other areas, identification with union leaders is a handicap. In older industrial areas, medical programs are widely used; in newer industrial areas, optometrists find it easier to initiate programs where there have been none before.

ACCOMMODATION AND CONVERGENCE RESPONSES IN BEGINNING AND ABSOLUTE PRESBYOPES*

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The existence and importance of accommodative convergence have been thoroughly established and accepted. However, the existence and importance of convergence accommodation (accommodation changes attributed to convergence changes) are still questioned.[1, 2]

A major reason for lack of substantial evidence pertaining to convergence accommodation has been the difficulty in determining whether changes in accommodation were due to convergence changes. This, in turn, has been partly due to the difficulty of preventing a blur stimulus to accommodation while changes in convergence stimulation were introduced. That is, if convergence changes do produce a change in accommodative response, then the test target will blur, assuming a fixed stimulus to accommodation, and the blur, in turn, will provide a stimulus directly to accommodation.

In order to overcome this problem, Fincham[3] recently conducted an experiment on two subjects employing a pinhole disk. The resulting depth of focus provided a clear image without producing a demand upon accommodation, and enabled accommodative changes to take place without a subsequent blur. He found with this method that convergence changes did produce changes in accommodation. More recently, Morgan[4] performed a similar experiment on one subject, employing a pinhole disk, and also found that convergence changes produced changes in accommodation, that a change of 14 or 15 prism diopters in convergence produced a 1.00 diopter change in accommodation.

Another approach to the measurement of convergence accommodation would be to keep the subject blurred at all times by testing at distances beyond the apparent amplitude of accommodation and noting if convergence changes can produce an increase in accommodative response. This is, of course, testing for the function under the most difficult

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The authors express thanks to Drs. Henry A. Knoll and Bud Tims for their assistance with the instrumentation employed in this study.
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conditions, as the apparent amplitude of accommodation will be in use. and further increases in accommodative response will be limited by the physical ability of the accommodative mechanism to respond to convergence stimulation. Thus, increases in accommodative response through convergence change under these conditions might be expected to be small, if present at all. Also such changes, if found, would not necessarily indicate a completely accurate C.A./C. ratio, since the accommodative mechanism would not be free to change to its fullest extent from convergence changes. Even though these conditions provide serious obstacles to the detection of convergence accommodation, the authors are of the opinion that it offers a worthwhile avenue of investigation and the present paper reports on such a technique to determine this function.

In order to note whether convergence changes can produce an increased amplitude of accommodation, it is necessary to provide an increase in convergence stimulation significantly greater than that demanded by the distance of the apparent amplitude of accommodation. This can best be accomplished on presbyopes whose near point of accommodation falls further than 20 cm. from the spectacle plane.

Such presbyopes also are excellent subjects for the determination of proximal convergence, since increase in accommodative response and, thus, accommodative convergence, would be of small magnitude, if present at all, at the closer distances. Thus, proximal convergence can be determined without the need of placing additional convex or concave lenses before the eyes, a procedure heretofore necessary for its measurement. Since the presbyope has not been previously examined from this standpoint, the authors felt it was worthwhile to conduct such an investigation.

Thus the aims of this experiment are to investigate: (1) convergence accommodation, and (2) proximal convergence, in both the beginning and absolute presbyope.

INSTRUMENTATION AND PROCEDURE

The instrument used in this experiment was an overhead haploscope* designed to rotate about centers of rotation corresponding to those of the eyes. Thus the center of rotation of each arm was 2.7 cm. behind the spectacle plane, and their separation was varied to correspond with the distance P.D. of the subject. The instrument was fitted with semi-silvered mirrors.

Accommodative response was measured by a system based upon

*Designed originally by Drs. Henry Knoll and Henry W. Hofstetter and modified by the senior author.

light threshold.[5] This involved the use of a thin, vertical, trans-illuminated slit, 0.5 mm. wide and 2 cm. long, over which was placed an Eastman-Kodak N-61 filter, designed to prevent color changes with changes in intensity of illumination of the slit brought about by the use of a variac. The slit, representing the optometer pattern, was collimated by a plus 5.00 diopter lens, and the collimated rays were then reflected off the semi-silvered mirror into the subject's eye. Only the left eye was used to measure accommodative response.

The light intensity was increased far above the subject's threshold and, while he fixated the test target, the arm was moved until the green line appeared to pass through the fixated target. The carrier for the slit was then moved in and out along the arm several times until the point where the line appeared sharpest and brightest was accurately determined. With the carrier set at this point the light intensity was reduced until the line disappeared. Then, as the subject carefully and steadily fixated the target, the variac was slowly turned up until the line was just noticeable. (The subject was instructed to keep the target as clear as possible during this entire procedure and to tap when the line was first seen.) This was repeated until consistent threshold measurements were established. This threshold level was then maintained throughout the remainder of that test. The carrier was then moved along the arm away from the subject's eye until the line target disappeared. Following this, the carrier was moved slowly in, toward the subject's eye, until the line target was just seen. This position was noted and the carrier was moved further in until the line again disappeared. The carrier was then moved slowly out, away from the subject's eye, until the line again was just seen, and this position was noted. Since the light intensity of the slit was of threshold value, it could be seen only when the slit image was conjugate with the observer's retina. Furthermore, since the slit was not observed at any other time, this obviated the risk of the observer's fixating for the slit rather than the target out in space, which could, of course, have changed the accommodative posture of the eye. For statistical purposes, ten such "in" and ten such "out" determinations were made for each attempt to measure accommodative response, and the average of the total ten "in" and "out" averages was taken as the accommodative response at the particular demand. By using such a system, no opportunity was given to the subject to fixate on, and accommodate for, the haploscopic measuring target, and the criterion of measurement—that is, not seeing or seeing the line target—left little room for variation due to the interpretative ability of the subject. Thus the authors believe that this

method offers an extremely delicate and precise means of determining accommodative response. Room illumination from 6 meters to 10 cm. varied between 10 and 15 foot-candles.

The testing procedure was as follows: the subject's push-up amplitude of convergence was determined through the distance prescription. The push-up amplitude of accommodation was then determined, both monocularly and binocularly, through the distance prescription by moving a chart containing Snellen type of various sizes in the midsagittal plane at eye level toward the eyes until beginning blur was first noticed for the smallest readable letters. As the chart was moved closer to the eyes, the subject was instructed to read the smallest letters possible and if, as the chart came closer, the letters remained clear, to fixate the next smaller letters. This was continued until finally a beginning blur was noted. Since all the subjects had 20/20 or better vision, it can be assumed that the visual angle remained fairly constant by this method and that 20/20 size letters were fixated at the onset of blur. On the younger subjects minus lenses were used to move the near point of accommodation farther than 20 cm. from the spectacle plane, and on the absolute presbyopes (over 70 years), this measurement was not taken, since the amplitude of accommodation was considered negligible.

With the distance P.D. determined and set in the haploscope, the subject was seated beneath the haploscope and properly aligned with the spectacle plane. The subject was instructed to fixate at 20/20 letter 6 meters distant at eye level in the midsagittal plane. The phoria was then determined by placing an excluding filter before the right eye, reflecting a small spot of light into the right eye by means of a semi-silvered mirror on the right arm, and then moving the arm until the subject reported that the spot of light appeared to be on the letter fixated by the left eye. The apparatus for the right eye, therefore, constituted a stigmatoscope. This procedure was repeated several times until consistent results were obtained.

In order to determine precisely the convergence response (and, hence, also demand) for the right eye, the left eye was occluded and the stigmatoscopic target to the fixating right eye was again positioned so that it appeared on the fixated target. The right eye was then occluded and, with the left eye now fixating, the haploscopic line target was presented to the left eye and the arm moved until it appeared to pass through the fixated target. This provided a reading of the convergence response (and demand) to the left eye. The sum of these two represented the total convergence response (and demand). The accommodative response was then determined in the manner previously described.

PATIENT	AGE	MONOC. PUSH UP AMPL. OF ACC.	DUANE EXPECTEDS L	M	H	PUSH UP MONOC. ACC. RESP.	MONOC. MAX. DEPTH OF FOCUS	PUSH UP BINOC. ACC. RESP.	BINOC. MAX. DEPTH OF FOCUS	BINOC. PUSH UP AMPL. OF ACC.	PUSH UP MONOC. ABS. AMP. OF ACC. (RESP.)	PUSH UP BINOC. ABS. AMP. OF ACC. (RESP.)	AUX. LENSES AT NEAR	MONOC. MAX. ABS. OF ACC. AT 100 CM. (RESP.)	BINOC. MAX. ABS. DISPL. OF ACC. AT 100 CM. (R.
F.B.	30 5/12	8.94	7.1	8.9	10.4	6.72	6.92	6.95	7.36	7.46	-	-	-3.00	-	-
G.G.	30 8/12	7.68	6.7	8.6	10.2	5.79	6.29	-	-	-	-	-	-2.00	-	-
V.R.	33 1/12	-	6.1	8.0	9.6	-	-	6.93	-	7.10	-	-	-2.00	-	-
M.S.	35 1/12	5.63	5.6	7.3	8.9	5.07	5.79	5.17	5.80	5.63	4.50	4.62	-2.50	5.64	6.05
E.T.	35 10/12	6.27	6.3	7.1	8.6	5.48	5.95	5.12	5.26	5.79	-	-	-2.00	-	-
M.N.	37	4.11	4.9	6.6	8.2	4.34	4.80	4.52	4.69	4.42	3.71	3.83	-2.00	3.88	4.85
H.W.	39	5.25	4.3	6.2	7.6	4.74	5.31	4.79	5.12	5.25	4.10	4.25	-2.00	4.43	4.75
C.A.	39 3/12	4.25	4.3	6.2	7.6	3.92	4.26	3.93	4.21	4.25	3.12	3.33	-1.00	3.37	4.14
D.G.	41 1/12	3.32	3.6	5.4	6.8	2.69	2.88	2.65	2.99	3.32	2.13	2.06	-	2.24	2.14
G.W.	45	2.42	2.2	3.7	5.2	1.50	1.72	2.42	2.67	2.55	0.94	2.08	-	1.75	2.69
C.M.	46 3/12	1.37	1.7	2.8	4.3	0.95	1.35	0.90	1.22	1.61	0.53	0.57	-	0.73	1.29
H.J.	46 1/2	0.79	1.5	2.5	3.9	0.34	1.27	0.43	0.87	1.38	-0.09	0.32	-	0.01	1.21
G.W.	48	0.72	1.3	2.2	3.4	0.59	0.81	0.54	0.97	0.84	0.12	0.18	-	0.40	0.77
H.V.	49	1.86	1.3	2.2	3.4	1.64	2.22	2.01	2.02	2.32	0.89	1.11	-	1.75 / 0.49	2.68 / 1.23
F.W.	72	-	0.7	1.1	1.5	0.66	1.07	0.58	0.81	-	0.12	0.03	-	0.08	-0.04
A.N.	74	-	0.7	1.1	1.5	1.27	2.05	1.31	1.42	-	0.29	0.09	-	0.35	0.00

Table 1. Summary of Accommodation Data. (Note:—Abs. Amp. of Acc. refers to the amplitude of accommodation minus the amount of accommodation haploscopically measured at 6 meters).

The occluder was then removed from the right eye, and with binocular fixation and fusion present, the accommodative response was again determined.

This procedure was then repeated at distances of 1 meter, 50 cm., 40 cm., 33.3 cm., 20 cm., and 10 cm., and at a distance corresponding to the closest binocular push-up amplitude of accommodation found during its measurement. The reference point for these distances is the base line in the midsagittal plane. For distances farther than and equal to the binocular push-up amplitude of accommodation, a single letter corresponding to 20/20 vision was fixated. For distances closer than the binocular push-up amplitude of accommodation, a letter of a size that could be distinguished, even though blurred, was used. The subjects were aware of the actual testing distance in each instance.

It was found that the smaller changes in fixation distance, as at 50 cm., 40 cm., and 33.3 cm., did not provide sufficient change in convergence stimulation to affect the responses significantly, and the procedure was, therefore, modified for subsequent subjects to tests conducted at 6 meters, at the distance of the binocular push-up amplitude of accommodation, and at 10 cm.

During the test procedure, the subject was given frequent rest periods and during the binocular test at the 10 cm. fixation distance, the subject was permitted to look down between measurements if difficulty in maintaining fusion was present. A few subjects of an age

younger than had originally been contemplated were used to gain further information for comparative purposes. The age range thus was from 30 to 74, with 16 subjects tested.

RESULTS AND DISCUSSION

The results obtained on each subject are presented in Table I. A number of points may be noted on inspection. Characteristically there is an increase in accommodative response associated with the increased convergence present in the binocular condition over that of the monocular condition, particularly at the 10 cm. testing distance. This is true in all cases excepting D.G., F.W., and A.N., the latter two subjects being over 70 years of age. An increase in accommodative response over that found at the push-up level of accommodation is present monocularly as well as binocularly in many cases at distances closer than that delimited by the push-up level of accommodation. The increase in proximal convergence with reduction in fixation distance is very marked in the younger subjects and is very slight in the older subjects. In case G.W. (age 49) there is an actual decrease in proximal convergence at the 10 cm. testing distance and in case F.W. the amount

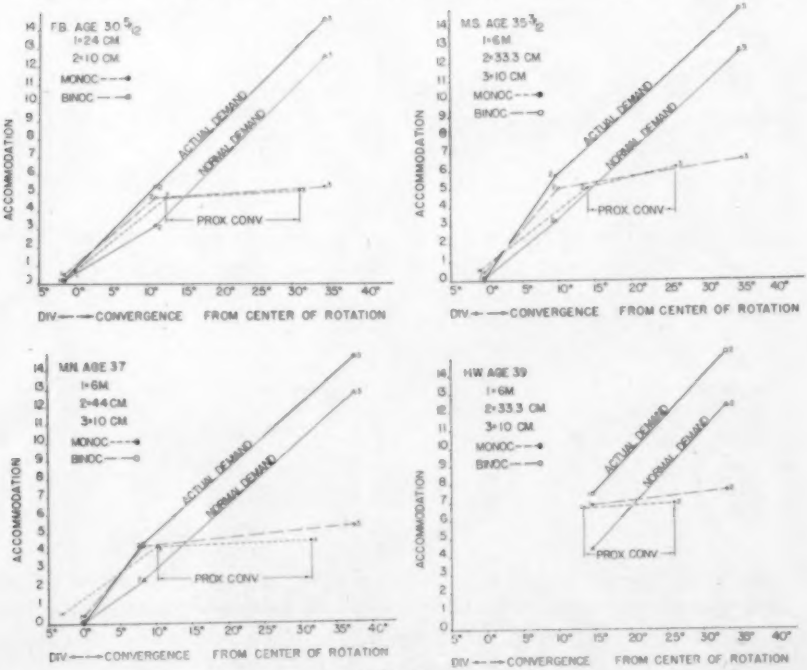

Fig. 1.

present is negligible. It will also be noted that the resting position of accommodation at 6 meters tended to be lower under binocular conditions than monocular conditions, this being true of all cases excepting again D.G., F.W., and A.N. The reduction in amplitude of accommodation with age is fairly consistent and the amplitude beyond the age of 48 is extremely small (excepting case H.V.). When monocular and binocular accommodative responses were measured haploscopically at the distance corresponding to that of the binocular push-up amplitude, the responses were found to be quite similar to the push-up amplitude of accommodation. See Figures 1, 2, 3 and 4.

In Figure 5 is shown the accommodative response, monocularly and binocularly, for each subject at the 10 cm. testing distance, with the convergence changes between the monocular and binocular tests. It is seen that with the increase of convergence—i.e., fusional convergence—in play, a higher accommodative response was found in the majority of subjects (cases D.G., F.W. and A.N. being the exceptions.

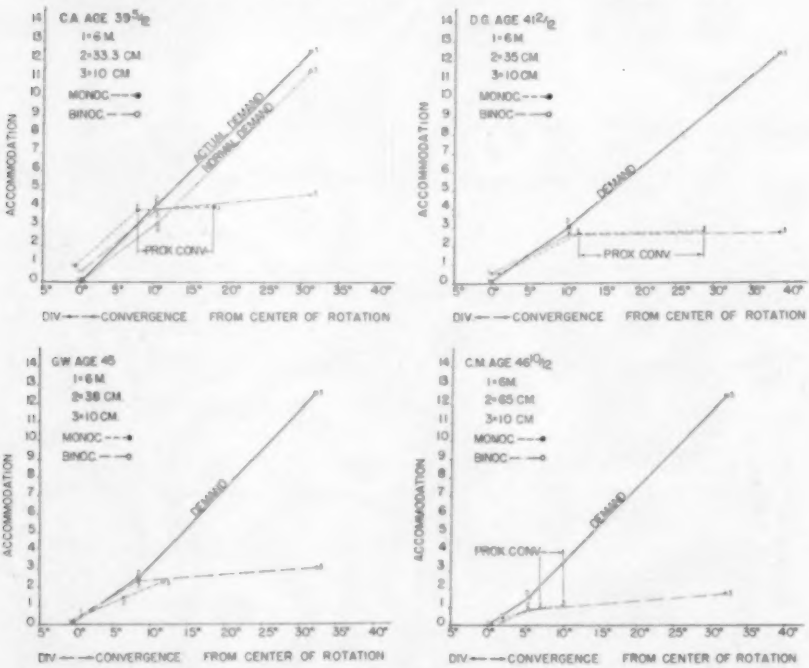

Fig. 2.

as stated earlier). The standard deviation was determined for each subject in regard to the monocular and binocular responses at this 10 cm. level and the probability of the difference between the monocular and binocular response being due to chance was then determined. It was found that for 9 subjects (H.J., M.N., M.S., G.W., H.V., F.B., C.M., C.A., and G.W.)* the probability of the difference being due to change was less than 0.001, for H.W. it was 0.04, for D.G. 0.06, F.W. 0.02 and A.N. 0.03. These differences are therefore statistically significant.

From this it would appear that convergence does elicit accommodation and, therefore, that convergence accommodation does exist. It also appears: (1) that the maximum accommodative amplitude is not obtained at the push-up level of accommodation in subjects who are not absolute presbyopes, but at a point corresponding to the amplitude of convergence (if it is closer to the eye than the near point of accommodation); (2) that the accommodative amplitude will increase even

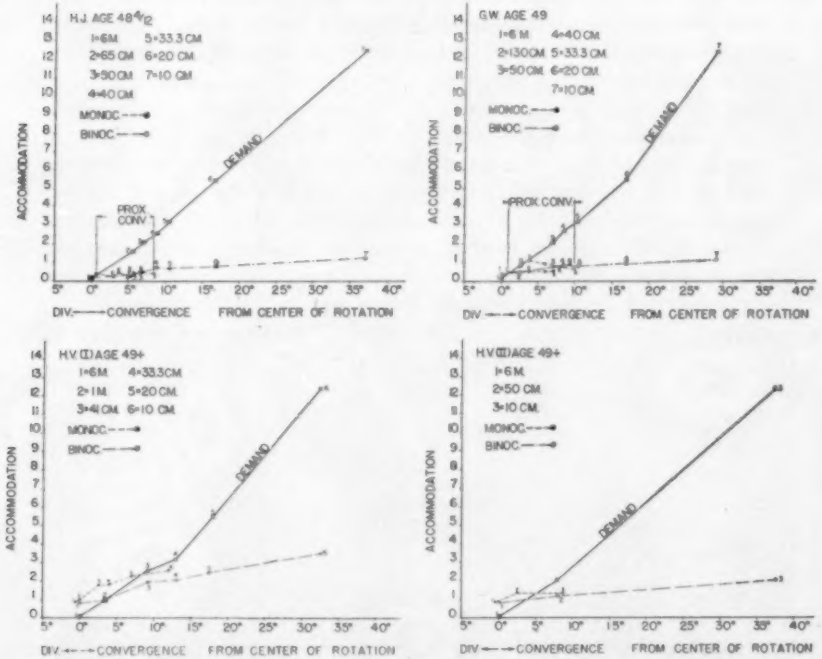

Fig. 3.

*There are two subjects with the intials G. W., one age 49, the other age 45.

though vision is blurred: and (3) that the graphic representation of accommodative amplitude as a horizontal straight line does not demonstrate the increase with increased convergence. Figure 6 demonstrates the characteristic picture found.

During the testing of accommodative response, the subjects characteristically demonstrated a pattern of response that made the effect of increased convergence very evident. The subjects would maintain very similar responses during the ten "in" and "out" trials monocularly as evidenced by the very small standard deviations found (usually less than 0.15 D.) but when the change was made to the binocular condition from the monocular (more convergence coming into play) there was a very abrupt increase in response which was consistently maintained.

The fact that convergence accommodation was not found on the absolute presbyopes would indicate that this function can no longer be elicited when the amplitude of accommodation becomes zero.

The fact that accommodative response increased under monocular testing distances closer than those determined for the push-up amplitude of accommodation, deserves comment. A possible explanation is that the increase was due to the increase in proximal convergence associated with the decrease in test distance: i.e., proximal convergence can produce convergence accommodation, as well as can fusional convergence. Another possibility is that the accommodative response from the previous binocular test was maintained to some extent when the next monocular test was performed at a closer distance. One subject (G.W., age 45) was examined to obtain further information regarding this aspect, and following the monocular test and binocular test, with the usual abrupt accommodative increase obtained, the monocular test was immediately repeated. It was found that the second monocular test produced an

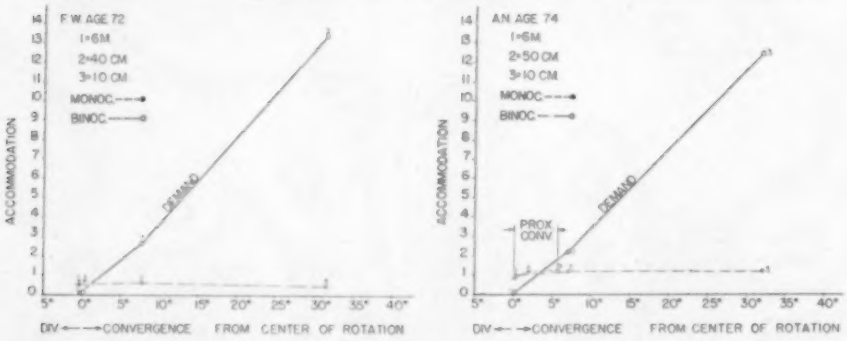

Fig. 4.

accommodative response less than the binocular test but more than the first monocular test. This would agree with Heath's[6] findings that the accommodative response from previous stimulation tended to be maintained. It is also possible that increased accommodative effort produced this monocular increase but this is considered doubtful since the subjects were urged to use their maximum effort at the push-up level tests and, thus, an increase in effort when the target was already blurred to a relatively large extent would seem unlikely. Heath[6] found, in fact, that the more excessively blurred the target became, the less was the accommodative response.

Examination was made of the monocular and binocular amplitude of accommodation both by the push-up method and by the haploscope, and of the relationships between them. The variation in amplitude of accommodation with age was also analyzed.

The push-up amplitudes of accommodation were calculated from the spectacle plane, and the Pythagorean Theorem was considered in such calculations, as the targets were in the midsagittal plane. A comparison of the monocular and binocular push-up amplitudes superposed on Duane's[7, 8, 9] high, medium, and low monocular expecteds, shows

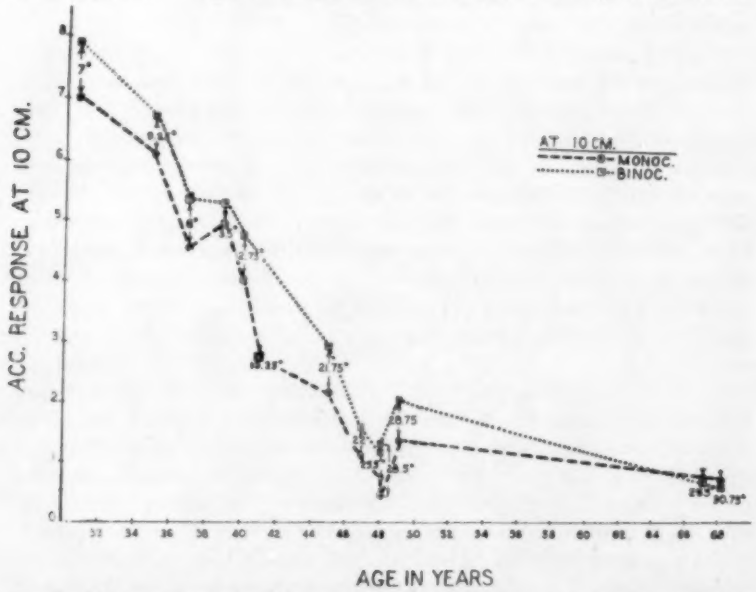

Fig. 5. Monocular and binocular accommodative responses at 10 cm. as a function of age. (Note:—Numbers between arrows refer to increase in convergence binocularly).

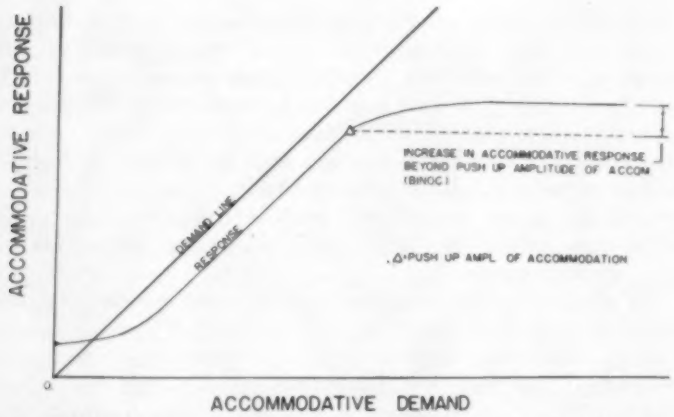

Fig. 6. Diagrammatic representation of typical binocular accommodative response changes with convergence stimulation at distances closer than the push-up amplitude of accommodation.

that the binocular push-up amplitude tended to be higher than the monocular push-up amplitude and that the findings coincided very closely with Duane's lower expecteds. See Figure 7.

In analyzing these results it is noted: (1) that the haploscopically measured monocular and binocular accommodative responses were quite close to the monocular and binocular push-up amplitude: (2) that there was a relatively sharp and consistent drop in accommodative response with age: (3) that the haploscopically measured accommodative response found at the distance at which the push-up amplitude was elicited was about the same whether one eye was fixating or both were fixating: and (4) that at about the age of 48 the accommodative response approached zero. This drop in amplitude of accommodation agrees with the findings of Hamasaki, Ong and Marg:[10] that is, by the age of 52 the haploscopically measured amplitude of accommodation is essentially zero.

The average difference of 1.75 D. between the push-up amplitude and the haploscopically determined accommodative response found by Hamasaki *et al* is greater than found here. Hamasaki *et al* attributed this difference to the depth of focus of the eye. The method employed in the present study to measure accommodative response in effect measured the depth of focus of the eye for the level of illumination used, and a depth of focus this great was not obtained even at the 10 cm. testing distance. It is felt that the method employed by Hamasaki and co-workers to measure the push-up amplitude is more likely

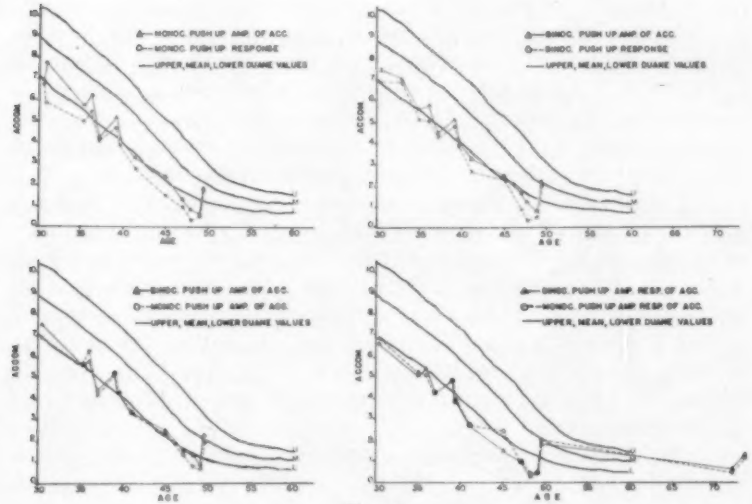

Fig. 7.

responsible for the difference. Six point type was used for all distances, and a +2.00 D. lens was placed before the eye (the test being performed monocularly). The visual angle would thus increase as the target was brought closer. Furthermore, the plus lens would produce some magnification and, being situated some distance in front of the eye, would have an effective power greater than +2.00 D. Duane, Donders,[11] and Kaufman[12] also used convex lenses on their older subjects and, thus, this same point can be raised concerning their technique. In the present experiment no additional lenses were used on the older subjects, and minus lenses were used on the younger subjects. With this method the push-up amplitudes found were smaller than those found in the references cited, and were in closer agreement with the accommodative responses found haploscopically.

Hofstetter,[13] in comparing Duane's and Donders' push-up findings, found that Duane's monocular findings were lower than Donders', and that Duane's binocular findings were also lower than Donders' for ages less than 20 and between 40 and 60.

He concluded that the difference in the 40 to 60 age group was attributable to the fact that Donders, by using a closer distance than Duane (Donders at 22 cm. and Duane at 50) obtained a greater accommodative effort. However, Donders, by using the closer distance, required a greater amount of convex lens power than Duane (or convex

power when Duane required none) and this use of greater convex lens power may also have been a factor in producing the greater push-up findings. That is, the magnitude of the push-up amplitude appears to be related to the type and amount of lens power used in the test. It appears from the data that Duane's lower expecteds provide the more accurate picture of the true push-up amplitude of accommodation and more closely correspond to the accommodative response present.

The data were analyzed in reference to the variation in proximal convergence with decrease in fixation distance. As was previously stated, considerable increase in proximal convergence was found with decrease in fixation distance in the younger subjects whereas very small increases were found in the older subjects. In fact, in one such older subject, a decrease was actually found and, in another, essentially no proximal convergence was found. This would indicate an apparent relationship between proximal convergence and age, which would bear further investigation.

During the phoria tests it was found that in the younger subjects (between the ages of 30 and 42) the occluded eye made a pronounced convergence movement at the 10 cm. test distance, whereas in the age range 45-49 there was a tendency to maintain the occluded eye in a straight ahead position until the closer points were reached, and then the occluded eye went into a proportionately greater and greater version movement. This became so pronounced in the one subject mentioned (G.W., age 49) that less, rather than more, proximal convergence was found at the 10 cm. distance. In the oldest subjects, ages 70 and 74, the occluded eye was in a nearly complete version position at each near distance.

The findings of Schapero and Levy[14] indicated that proximal convergence tended to increase in an accelerated manner with decrease in fixation distance in younger subjects. The findings here confirm this and also indicate that in older subjects it increases in a decelerated manner, if at all. The declining rate of increase in proximal convergence in older subjects would appear quite paradoxical since it can be assumed that they have just as great a sense of nearness as the younger subjects.

The psychic awareness of nearness *per se* thus may not be responsible for this convergence movement. When phoria measurements are taken it is usually assumed that the non-fixating eye goes into a version movement, less the accommodative convergence present. This is especially true since measurements for phorias are usually taken in the mid-sagittal plane, demanding an adduction movement of the fixating eye

and thereby an abduction movement of the non-fixating eye.*

Since in all normal binocular fixation responses at finite distances the eyes are in a convergence position, it may be reasoned, that even though one eye is occluded, there is a continued awareness of a convergence demand and therefore a carry-over of the neuromuscular response associated with convergence stimulation to the non-fixating eye in the phoria test, that this eye thus tends to remain directed toward the fixated object and maintain a convergence posture.

This type of response is manifested clinically subsequent to base-out training by patients exhibiting high exophorias. There is commonly a decided reduction in the measured exophoria which may be attributed to persistence of positive fusional convergence during the phoria test, and which may be present even when the test is conducted at infinity. In such cases the true phoria is revealed by utilizing loose prisms with the alternate cover test, the alternate fixation movement apparently breaking down the persistency of convergence.

The point may be raised that the absolute presbyope is as aware of a convergence demand as the non-presbyope, and that, since he must employ more fusional convergence than the younger subject, he should demonstrate at least as much of such a residual fusional movement as the younger subject. However, this does not necessarily follow. Hofstetter[15] found no correlation between the total fusional convergence available and the amount of proximal convergence present. Furthermore, it is often observed clinically that presbyopes encounter difficulty in recovering fusion following a dissociation test. The relief of convergence effort afforded by the dissociation test appears to be welcomed, with a reluctance to re-employ positive fusional convergence upon removal of the dissociation test. From this, it may be reasoned that, if there is a poor response in re-employing positive fusional convergence when fusion is possible, that there would be little likelihood of persistence of positive fusional convergence during a dissociation test in which fusion is rendered impossible. It may be speculated that the use

*As a subsidiary experiment to investigate the effect of the direction of the fixated target upon proximal convergence, one subject (M.N., age 37) was tested with the target 10 cm. from the left eye, first in the midsagittal plane, then directly before the left eye, and then 15 degrees temporally from the straight-head position of the left eye. The same amount of proximal convergence was found when the target was in the midsagittal plane and straight ahead of the left eye, but when the target was moved 15 degrees temporalward, 13 degrees less proximal convergence was found. In this latter test a version demand as well as a vergence demand was created, and the non-fixating eye tended to go into a more complete version movement. Thus a considerable reduction in proximal convergence was found, even though the test distance remained constant for one eye. Since this was performed on only one subject the authors intend to explore this aspect further in a later paper.

of fusional convergence to regain single vision is more closely related to proximal convergence than the total fusional convergence available.

Though the increase in convergence found under monocular conditions at distances closer than the push-up level of accommodation here has been considered proximal convergence, the authors have not overlooked the possibility that this increase could be partly due to accommodative convergence from physiological accommodation. There are several reasons why it is believed that this is not the case. If this increase in convergence were due to physiological accommodation, a tremendous increase in accommodative effort, over and above that at the push-up level of accommodation, would have to be present to account for the great convergence increase found in the younger subjects. That such an increase in effort would occur is extremely unlikely as the subject was urged to accommodate to his fullest extent at the push-up testing distance and thus was already exerting a maximum effort. Further, with the target blurred at the closer points, there was a tendency in the opposite direction—that is, to relinquish some of the effort, as manifested by the difficulty the subjects had in maintaining accommodation. Also, if an effort as great as would be necessary to produce this convergence change were present, one would expect the amplitude of accommodation to be at its greatest magnitude, with no further increase possible. However, increases were found binocularly when fusional convergence came into play. Also, since the convergence was measured under monocular conditions, with no demand on fusion, the need of such accommodative convergence to assist in fusion (a possibility mentioned by Alpern[16] to account for the increased convergence found at the upper levels of accommodation and convergence) was not present. That such an effort can even be elicited in the average observer is doubtful, as indicated by Morgan, who was unable to produce it in subjects when deliberate attempts were made to do so.

The tendency for the monocular resting position of accommodation at 6 meters to be higher than the binocular resting position in many of the subjects was statistically evaluated for significance. The standard deviation for both the monocular and binocular accommodative responses was extremely small (less than 0.10 D. in almost every case) and the probability of the difference occurring by chance was less than 0.001 in 6 cases (H.J., M.N., H.W., C.M., C.A., and G.W.). The difference between the binocular and monocular resting position of accommodation found in these cases ranged from 0.12 D. to 0.40 D. The same trend was found in cases M.S., G.W., and H.V., but their differences were not significant. In cases D.G., F.W., and A.N., the

reverse was found: that is, the binocular resting position was higher than the monocular resting position, but the difference was not significant except in case A.N., where the probability was 0.028. Thus binocular fixation appears to exert an effect upon the resting state of accommodation. How this occurs remains to be determined.

SUMMARY AND CONCLUSIONS

An investigation of convergence accommodation and proximal convergence was made on beginning and absolute presbyopes by determining convergence and accommodative responses at and nearer than the binocular push-up amplitude of accommodation. It was found that convergence stimulation was able to cause statistically significant increases in accommodative response, thus indicating the possibility of convergence accommodation. In abolute presbyopes, however, this increase was not found, indicating apparent diminution of this function with age.

The push-up accommodative amplitude found binocularly tended to be higher than the push-up amplitude found monocularly and the corresponding accommodative responses measured by the haploscope tended to be fairly close to the push-up measurements.

The type and power of the lenses used in determining the push-up amplitude of accommodation appear to play a role in its magnitude. In this experiment, minus lenses, or no additional lenses, were used and the push-up accommodative amplitudes were lower than those of Donders, Duane, Kaufman, and Hamasaki *et al*, all of whom used convex lenses on older subjects. The Duane lower expecteds for the push-up amplitude of accommodation appear more closely to approach the haploscopically measured accommodative responses and therefore seem to present the most accurate estimation of amplitude of accommodation. Hamasaki, Ong and Marg's finding of virtually complete loss of accommodation by the age of 52 is corroborated.

The maximum accommodative response possible was characteristically found at distances approaching the near point of convergence and not at the near point of accommodation in all but the absolute presbyopes.

A marked increase in proximal convergence with decrease in fixation distance to 10 cm. was found in the younger subjects, with lesser increases found in the older subjects. The absolute presbyopes demonstrated the least proximal convergence of all the subjects. It was thus concluded that proximal convergence appears to be inversely related to age. An analysis of the position of the occluded eye during the phoria tests suggests that proximal convergence is a residual fusional con-

vergence movement due to awareness of a convergence demand, and varies with the ability of the occluded eye to resist going into a version movement.

A tendency for the binocular resting position of accommodation to be lower than the monocular resting position was found in younger subjects.

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SHORT SUMMER RESIDENCY AT INDIANA

The Division of Optometry, Indiana University has set up a course in practical clinical optometry to be given during the Summer of 1958. The course is designed to give the practicing optometrist an opportunity to return to school and to perform eye examinations under supervision, on clinic patients with the same training and consultation privileges afforded the undergraduate student in optometry. The enrollment will be limited to one optometrist per week and he will be expected to participate in the operation of the Summer Optometry Clinic along side two fifth-year optometry students who are assigned to Summer Clinic.

The program will include one refraction per day and a group discussion of each student's examination each day. There will be a period designated for the study of orthoptics instrumentation and techniques, and ample opportunity will also be available for individual study in the libraries on topics of individual interest and on the special reading materials which will be assigned.

The course will carry two hours of university credit and the tuition will be $14 for Indiana residents and $36 for others. Students may be assigned to any two week period from June 10, 1958, through September 5, 1958. Due to the limited enrollment facilities at any given time, the student is encouraged to request reservations for the particular two week period of his choice by writing directly to the Division of Optometry, Indiana University, Bloomington, Indiana.

HENRY W. HOFSTETTER

SHEARD RECEIVES TILLYER MEDAL

Dr. Charles Sheard, former professor of physics at The Ohio State University, received the Edgar D. Tillyer Medal of the Optical Society of America at a banquet held by the Society at the Deshler Hilton Hotel, Columbus, Ohio, October 18. The banquet was the highlight of the 42nd Annual Meeting.

At the same time the Frederick Ives Medal was presented to Professor Arthur C. Hardy of the Massachusetts Institute of Technology. After the presentation of the medals, Professor Samuel Renshaw of The Ohio State University Department of Psychology, who was guest lecturer for the occasion, spoke on the subject "Visual Form Perception."

Dr. Sheard came as an instructor in physics to The Ohio State University in 1907 and rose rapidly to a full professor. He initiated the work in Applied Optics from which has sprung the present-day School of Optometry. His pioneer work in opthalmic optics, dynamic skiametry and relations between accommodation and convergence laid the foundations for the modern practice of optometry.

The Sheard Foundation for Research in Vision at The Ohio State University has been established in his honor.

From 1919 to 1924, Dr. Sheard headed a program of scientific interests at the American Optical Company where he founded and served as editor of the AMERICAN JOURNAL OF PHYSIOLOGICAL OPTICS.

He then became professor of biophysics at the Mayo Foundation of the University of Minnesota and since 1949 has continued professor emeritus. He was also director of the Division of Physics and Biophysics at the Mayo Clinic.

Since his retirement he has served as professor of ophthalmic optics at Rochester College; president and secretary of the American Board of Opticianry, and distinguished lecturer in ophthalmology, Graduate School of Medicine, Tulane University, New Orleans. During 1952-53 he served as interim dean of the Los Angeles College of Optometry.

Dr. Sheard has published over 300 papers and a number of books and is the inventor of several scientific instruments.

He has received numerous degrees which include the A.B., M.A. Ph.D., and two honorary degrees, the D.Sc. and the D.O.Sc.

He is a member of numerous societies and academies. He is an honorary member of the American Academy of Ophthalmology and Otolaryngology, and received the Academy's honor award in 1951. Optometry has honored him with a life membership in the American Optometric Association, the bestowal of the Distinguished Service Medal in 1930 and a life fellowship in the American Academy of Optometry of which he was one of the founders.

Dr. Sheard gave the Thomas Young Oration at London in 1921, and received the Burdick Award and Medal in 1947 and the Nelson Achievement Award in 1951.

His latest recognition comes as a successful effort on the part of his friends in optometry, ophthalmology and opticianry to republish some of the out-of-print material from his contributions as a book, *The Sheard Volume: Selected Writings in Visual and Ophthalmic Optics.* The book has just been published by the Chilton Press.

HERBERT G. MOTE

ACCELERATED COURSES

A review of the literature makes it clear that undergraduate medical education is under close study and that certain changes in the duration of the courses are being considered. The recently announced program of Johns Hopkins University School of Medicine is typical. Accelerated courses will be offered to exceptional students permitting this group to reduce the time element of the course as much as from one to two years.

Optometry should also consider this matter. Accelerated courses, for those students who can carry them properly, might be arranged and this could prove to be a factor in increasing student enrollment. The Association of Schools and Colleges in Optometry should put the consideration of this matter high on the list of things to be considered during 1958.

CAREL C. KOCH

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

PROGRAM OF THE AMERICAN ACADEMY OF OPTOMETRY

The Drake Hotel
Lake Shore Drive and Upper Michigan Ave.
Chicago, Illinois
Post-Graduate Courses, December 4, 5 and 6, 1957
Annual Meeting of the Academy, December 7, 8, 9 and 10, 1957

WEDNESDAY, THURSDAY and FRIDAY
December 4, 5 and 6, 1957

9:00 A. M. to 10:00 P. M. American Academy of Optometry, Post-Graduate Courses.* Apply at Registration Desk for tickets and program.

10:00 A. M. to 5:00 P. M. American Academy of Optometry, Executive Council meetings. See Bulletin Board for Room number. All Academy members welcome to attend sessions.

FRIDAY, December 6, 1957

9:30 A. M. to 4:00 P. M. American Academy of Optometry, Committee on Admittance. Applicants meet with Committee on Admittance to complete their Clinical Examinations. See Bulletin Board for Room number.

SATURDAY, December 7, 1957

8:30 Registration.

10:00 Business Meeting.
President's Annual Report.
Robert W. Tubesing, O.D.
Secretary's Annual Report.
Carel C. Koch, O.D.
Announcements by Chairman of the
Papers and Program Committee.
Ralph E. Wick, O.D.

*For a detailed review of these 52 courses see following: Vincent J. Ellerbrock, et al., Post-Graduate Courses of American Academy of Optometry. Am. J. Optom. & Arch. Am. Acad. Optom. 34.8.451-462.1957 and 34.9.511-522.1957.

Announcements by Chairmen of the Sections:

Jay M. Enoch, O.D., Ph.D.
Section on Pathology.

Bernard Mazow, O.D.
Section on Contact Lens Fitting and Sub-Normal Vision.

Oscar L. McCulloch, O.D.
Section on Aniseikonia and Refractive Problems.

Herman Sager, O.D.
Section on Occupational Optometry.

John Zettel, Jr., O.D.
Section on Orthoptics.

10:40 Accommodative Response to Near Cross Cylinder Test.
Gerald Westheimer, O.D., Ph.D., School of Optometry, The Ohio State University, Columbus, Ohio.

11:05 Discussion.

11:10 An Evaluation of Children's Visual Achievement Forms at Grade I.
Helen M. Robinson, Ph.D., Associate Professor of Education, University of Chicago, Chicago, Illinois.

11:35 Discussion.

11:40 The Effect of Blurred Imagery on Visual Acuity With Implications for Sub-Normal Vision.
V. J. Ellerbrock, O.D., Ph.D., School of Optometry. The Ohio State University, Columbus, Ohio.

12:00 Discussion.

12:05 Luncheon Recess.

1:30 An Evaluation of the Massachusetts Vision Screening Test.
Robert S. Arner, O.D., Brooklyn, New York.

1:55 Discussion.

2:00 Changes in Refraction After Twenty Years in a Non-Selected Sample.
Meredith W. Morgan, Jr., O.D., Ph.D., School of Optometry, University of California, Berkeley, California.

2:25 Discussion.

2:30 A New Astigmatic Test Chart.
Sylvester K. Guth, B.S., D.O.S., Radiant Energy Effects Laboratory, General Electric Company, Nela Park, Cleveland, Ohio.
A. A. Eastman, B.S., Radiant Energy Effects Laboratory, General Electric Company, Nela Park, Cleveland, Ohio.

2:55 Discussion.

3:00 Ophthalmographic Studies of Search.
Jay M. Enoch, O.D., Ph.D., School of Optometry, The Ohio State University, Columbus, Ohio.

3:25 Discussion.

3:30 A Scientific Approach to the Prescribing of Corneal Type Contact Lenses.
Harold I. Moss, O.D., Wilmington, Delaware.

3:55 Discussion.

4:00 Optometric Findings on Identical Twins.
Theodore Grosvenor, O.D., Ph.D., College of Optometry, University of Houston, Houston, Texas.

5:25 Discussion.

4:30 Night Driving Seeing Problems.
Oscar W. Richards, Ph.D., American Optical Company, Southbridge, Massachusetts.

4:55 Discussion.

5:00 Projection in Anomalous Correspondence.
Neal J. Bailey, O.D., Ph.D., Division of Optometry, Indiana University, Bloomington, Indiana.

5:25 Discussion .

Members and guests of the Academy are invited to attend the Annual Banquet of the Illinois Optometric Association at the Morrison Hotel. Academy Registration Badges should be worn and Illinois Optometric Association banquet tickets may be secured at Registration desk. The ticket will include cocktail hour, banquet and evening of entertainment and dancing that follows banquet.

6:30 Cocktail hour, Parlors B, C and D of Morrison Hotel, Chicago. Courtesy of the Optical Manufacturers and Laboratories.

7:30 Annual Banquet. Illinois Optometric Association. Grand Ballroom, Morrison Hotel, Chicago. Master of Ceremony, Senator George Drach of Illinois.

SUNDAY, December 8, 1957

9:00 Section Meetings. (See individual Section Programs).*

11:10 Recent Developments in Techniques for Measuring Astigmatism.
Robert E. Bannon, O.D., American Optical Company, Southbridge, Massachusetts.

*For review of these five Section Programs see following: Ralph E. Wick and Donald A. Springer. Further Notes on the Coming Academy Meeting. Programs of Five Sections. Am. J. Optom. & Arch. Am. Acad. Optom. 34.10.575-579. 1957.

11:35 Discussion.

11:40 Original Slides Illustrating Various Aspects of Cosmetic Dispensing.
Margaret S. Dowaliby, O.D., Los Angeles College of Optometry, Los Angeles, California.

12:05 Discussion.

12:10 Luncheon Recess.
The Academy will meet with the members of the Illinois Optometric Association in the Grand Ballroom of the Morrison Hotel, Chicago, for the Sunday Afternoon Sessions.

1:30 The Problem of Headaches in Optometric Practice.
Harold Simmerman, O.D., Pennsylvania State College of Optometry, Philadelphia, Pennsylvania.

3:00 Orthoptics Symposium.
John Zettel, O.D., Chairman, Cincinnati, Ohio.
Introductory Remarks.
Meredith W. Morgan, Jr., O.D., Ph.D., School of Optometry, University of California, Berkeley, California.

3:10 Diagnosis and Correction of Suppression.
Daniel Woolf, O.D., Ph.D., New York, New York.

3:35 Diagnosis and Correction of Amblyopia.
Max Schapero, O.D., Los Angeles College of Optometry, Los Angeles, California.

4:00 Diagnosis and Correction of Eccentric Fixation.
Neal J. Bailey, O.D., Ph.D., Division of Optometry, Indiana University, Bloomington, Indiana.

4:25 Diagnosis and Correction of Anomalous Correspondence.
Jack M. Fugate, O.D., Ph.D., School of Optometry, The Ohio State University, Columbus, Ohio.

4:50 Prognosis in Strabismus.
Merton C. Flom, O.D., Ph.D., School of Optometry, University of California, Berkeley, California.

5:15 Discussion.

6:00 Dinner Recess.
The Academy will meet in the Drake Hotel for the Sunday Evening Sessions.

7:45 The Changing Concept in Styling and Dispensing.
Marshall S. Olson, Vice-President and Director of Sales, Benson Optical Company, Minneapolis, Minnesota.
Rudolph Ehrenberg, O.D., Granite Falls, Minnesota.

8:10 Discussion.

8:15 British Optometry.
Norman Bier, F.B.O.A., (Hons.) D. Orth. London, England.
8:40 Discussion.
8:45 New Reading Material for Sub-Normal Vision Subjects.
Jack H. Prince, F.B.O.A., F.S.M.C., F.R.M.S., (Eng.) Department of Ophthalmology, Medical School, The Ohio State University, Columbus, Ohio.
9:05 Discussion.
9:10 Sociological Perspective of Optometry.
John R. Uglum, O.D., Reno, Nevada.
Lewis Orzack, Ph.D., Department of Anthropology and Sociology, University of Wisconsin, Madison, Wisconsin.
9:30 Discussion.

MONDAY, December 9, 1957

9:00 Section Meetings. (See individual Section Programs)
11:10 Referrals from Visual Screening Procedures.
Vernon Ryan, O.D., Pennsylvania State College of Optometry, Philadelphia, Pennsylvania.
11:35 Discussion.
11:40 The Configuration and Orientation of Test Patterns Used with the Homokonic Cross Cylinder for Measurement of Astigmatism.
Phillip R. Haynes, O.D., Newark, Ohio.
12:00 Discussion.
12:05 Luncheon Recess.
1:15 An Estimate of the Hereditary Component of Myopia.
Francis A. Young, Ph.D., Department of Psychology, State College of Washington, Seattle, Washington.
1:35 Discussion.
1:40 The Empirical Longitudinal Horopter in Anomalous Correspondence.
Merton C. Flom, O.D., Ph.D., School of Optometry, University of California, Berkeley, California.
2:05 Discussion.
2:10 A Study of the Relative Effect of Heredity and Environment Upon the Refractive Errors and Other Optical Characteristics of Identical Twins, Fraternal Twins, and Like Sex Siblings.
R. J. Wixson, O.D., Shamokin, Pennsylvania.
2:35 Discussion.

2:40 Osmotic Effect of Lacrimal Fluid as Determined by Summation Halometry.
Isidore S. Finkelstein, O.D., Ph.D., Physicist, Servo Corporation of America, New York, New York.
3:00 Discussion.
3:05 The Application of Contact Lenses in Cases of Psychoses and Neuroses.
L. Lester Beacher, O.D., Sc.D., East Orange, New Jersey.
3:25 Discussion.
3:30 The Relationship Between Measured Intelligence and Refractive State in a Selected High School Sample.
Melvin C. Nadell, O.D., Ph.D., Los Angeles College of Optometry, Los Angeles, California.
3:55 Discussion.
4:00 Business Meeting.
Robert W. Tubesing, O.D., Presiding.
Members and guests of the Illinois Optometric Association are invited to attend the Annual Roundtable Dinner of the American Academy of Optometry at the Drake Hotel. Tickets may be secured at the Registration Desk.
6:00 Cocktail Hour.
7:00 Annual Roundtable Dinner.
The American Optometric Association in Present Day Optometric Affairs.
Lester H. Sugarman, O.D., Meriden, Connecticut.
A Comprehensive Survey of the Role of Optometry and Its Educational Needs.
Henry W. Hofstetter, O.D., Ph.D., Division of Optometry, Indiana University, Bloomington, Indiana.

TUESDAY, December 10, 1957

9:00 Section Meetings. (See individual Section Programs)
11:10 The Theory and New Development in the Application of the Bichrome Test.
Robert B. Mandell, O.D., Division of Optometry, Indiana University, Bloomington, Indiana.
Merrill J. Allen, O.D., Ph.D., Division of Optometry, Indiana University, Bloomington, Indiana.
11:35 Discussion.
11:40 Refractive Changes After the Age of Forty-Five.
Monroe J. Hirsch, O.D., Ph.D., Ojai, California.
12:05 Discussion.

12:10 Luncheon Recess.
1:15 Raubitschek Astigmatism Test.
Jess B. Eskridge, B.S., M.Optom., College of Optometry, University of Houston, Houston, Texas.
1:40 Discussion.
1:45 Credit Control in a Professional Practice.
Marshall S. Olson, Vice-President and Director of Sales, Benson Optical Company, Minneapolis, Minnesota.
Ralph E. Wick, O.D., Rapid City, South Dakota.
2:10 Discussion.
2:15 Visual Screening in R-1, A Pattern of Interprofessional Relations.
Otto J. Bebber, O.D., Denver, Colorado.
2:40 Discussion.
2:45 Visual Problems of the Aged.
Bernard Mazow, O.D., College of Optometry, University of Houston, Houston, Texas.
3:10 Discussion.
3:15 Convergence Accommodation.
Comdr. Paul R. Kent (MSC), U.S.N., Great Lakes, Illinois.
3:40 Discussion.
3:45 A Five Year Study of the Scholastic Aptitude and Reading Competence of Optometric Students.
Alfred A. Rosenbloom, Jr., M.A., O.D., Illinois College of Optometry, Chicago, Illinois.
4:10 Discussion.
4:15 Adjournment.

PROGRAM OF THE ILLINOIS OPTOMETRIC ASSOCIATION

The Morrison Hotel
Chicago, Illinois

SATURDAY, December 7, 1957

8:00 Registration.
10:00 Business Meeting.
Invocation and Memorial Services.
James Molenaar, O.D.
Address of Welcome.
Eugene W. Strawn, O.D.
Call to Order, House of Delegates.
Ralph Barton, O.D., President

12:00 Luncheon Recess.

2:00 Cosmetic Considerations of Eyewear.
Margaret S. Dowaliby, O.D., Los Angeles College of Optometry, Los Angeles, California.

3:30 The Professional Eyeman Can Double His 'Take-Home Pay.'
Virgil Hancock, Modern Optics, Inc., Houston, Texas.

4:30 What We Can Learn From Europe.
Otto R. Engelmann, O.D., Chicago, Illinois.

5:15 Recess.
Members and guests of the American Academy of Optometry are invited to attend the 50th Annual Banquet of the Illinois Optometric Association.

6:30 Cocktail hour, Parlors B, C and D. Courtesy of Optical Manufacturers and Laboratories.

7:30 Annual Banquet. Grand Ballroom. Master of Ceremony, Senator George Drach of Illinois.

9:00 Dancing. Grand Ballroom. Lou Brownie and his Mercury Recording Orchestra. Refreshments courtesy of the Optical Manufacturers and Laboratories.

SUNDAY, December 8, 1957

Morning: Attend the Church of your choice.

12:00 Illinois College of Optometry, Alumni Luncheon. Cotillion Room.
On Sunday afternoon the Illinois Optometric Association and the American Academy of Optometry will have a joint educational meeting in the Grand Ballroom of the Morrison Hotel.

1:30 The Problem of Headaches in Optometric Practice.
Harold Simmerman, O.D., Pennsylvania State College of Optometry, Philadelphia, Pennsylvania.

3:00 Orthoptics Symposium.
John Zettel, O.D., Chairman, Cincinnati, Ohio.
Introductory Remarks.
Meredith W. Morgan, Jr., O.D., Ph.D., School of Optometry, University of California, Berkeley, California.

3:10 Diagnosis and Correction of Suppression.
Daniel Woolf, O.D., Ph.D., New York, New York.

3:35 Diagnosis and Correction of Amblyopia.
Max Schapero, O.D., Los Angeles College of Optometry, Los Angeles, California.

4:00 Diagnosis and Correction of Eccentric Fixation.
Neal J. Bailey, O.D., Ph.D., Division of Optometry, Indiana University, Bloomington, Indiana.

4:25 Diagnosis and Correction of Anomalous Correspondence.
Jack M. Fugate, O.D., Ph.D., School of Optometry, The Ohio State University, Columbus, Ohio.

4:50 Prognosis in Strabismus.
Merton C. Flom, O.D., Ph.D., School of Optometry, University of California, Berkeley, California.

5:15 Discussion.

5:30 Recess.

7:30 Illinois Chapter, American Academy of Optometry, Annual Dinner Meeting, Morrison Hotel.

MONDAY, December 9, 1957

9:00 Roundtable Discussions. Grand Ballroom.
(a) Local Society Problems.
(b) Public Relations.
(c) Legal and Civic Affairs.

10:00 Business Session.

12:00 Luncheon Recess.

1:30 Business Session.

5:00 Adjournment.

Members and guests of the Illinois Optometric Association are invited to attend the Annual Roundtable Dinner of the American Academy of Optometry at the Drake Hotel. Tickets may be secured at Registration desk.

6:00 Cocktail Hour (the Drake Hotel).

7:00 Academy Annual Roundtable Dinner (the Drake Hotel).

The American Optometric Association in Present Day Optometric Affairs.
Lester H. Sugarman, O.D., Meriden, Connecticut.

A Comprehensive Survey of the Role of Optometry and Its Educational Needs.
Henry W. Hofstetter, O.D., Ph.D., Division of Optometry, Indiana University, Bloomington, Indiana.

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

SPECTACLES FOR DIFFERENT USES

The subject of various spectacles for different purposes has been mentioned on a number of occasions. From one standpoint the whole question of appearance or style points up the need for more than one pair of spectacles for each wearer. In addition, the purpose for which spectacles are prescribed usually indicates that no one correction will best serve all needs.

Some time ago the OPTOMETRIC WEEKLY stressed the fact that there was really no all-purpose pair of spectacles. This was good. Now the Titmus Optical Company, Petersburg, Virginia, has a multiple Rx pad in which various types of spectacles are suggested for different uses, such as occupational wear, social wear, sun wear and hobbies or special focal-range wear. These suggestions, too, are excellent.

As a constant user of spectacles, I would like to add one more suggestion that I have found gives me much pleasure. I use a bifocal correction and I have come to believe that every bifocal user should also have an extra pair of single vision spectacles for reading only. I use mine for reading in bed and they are wonderful.

1958 OPTICAL FAIR CANCELLED

The Optical Manufacturers Association voted at its regularly quarterly meeting on October 24 to cancel plans for the 1958 Optical Fair and to hold in abeyance plans for future Optical Fairs until the relationship of the Fair to the regularly scheduled conventions of the various groups comprising the optical industry and professions can be clarified.

This action by the Optical Manufacturers Association was taken after a series of meetings between the Association's Industry and Professional Relations Committee and committees representing the American Optometric Association, Association of Independent Optical Wholesalers, Guild of Prescription Opticians, and Optical Wholesalers National Association. At these meetings it became evident that, in spite of the admitted advantages of an Optical Fair held periodically, it is impossible under present conditions so to schedule a Fair as to mesh geographically and chronologically with the convention commitments

and restrictive constitutional provisions of the various groups whose support is essential to a successful Fair.

The Optical Manufacturers Association is still hopeful that at some time in the future it may be possible to reconcile these differences and that the practice of holding periodic Optical Fairs with their large, colorful and varied exhibits, outstanding educational programs, large attendance from all levels of the industry and professions can be resumed.

POST-GRADUATE COURSES FROM UNIVERSITY OF HOUSTON

Faculty members of the University of Houston College of Optometry are now carrying post-graduate education directly to practicing optometrists. In a series of "Study-at-Home" post-graduate courses the instructor travels to his class and the students stay home.

Available throughout the year, these courses consist of 14 hours of class instruction. The courses have been designed with the idea of flexibility. Arrangements as to length of course and course material will be made as desired by the optometry group taking the course. Normally, each course consists of two hours on both Thursday and Friday evenings, and five hours on Saturday and also on Sunday. The faculty member teaching the course travels to any location designated by the participating optometrists.

The fee is $500 for the group regardless of the number taking the course. This includes the instructor's salary plus his expenses for meals, accommodations, travel, and necessary instructional material. For locations beyond 1,000 miles from Houston, a small additional charge will be made. These courses are available to groups of individual optometrists, local societies, and state association study groups.

Courses offered include: (1) Analytical Analysis of Optometric Data—Chester H. Pheiffer, O.D., Ph.D., associate professor of optometry; (2) Visual Training—Dr. Pheiffer; (3) Review of Basic Refraction Procedures—Darrell B. Carter, O.D., Ph.D., associate professor of optometry; (4) Modern Clinical Optometry—Dr. Carter; (5) Graphical Analysis of Optometric Data—Dr. Carter; (6) Non-Squint Orthoptics—J. Boyd Eskridge, O.D., assistant professor of optometry; (7) Sub-Normal Vision Procedures—Dr. Eskridge; (8) Refraction—Dr. Eskridge; (9) Ocular Pathology—Theodore P. Grosvenor, O.D., Ph.D., assistant professor of optometry; (10) Headache— Dr. Grosvenor; (11) Glaucoma—Dr. Grosvenor; (12) Applications of Ophthalmic Optics—Charles R. Stewart, O.D., Ph.D., dean, College of Optometry.

The courses already given have met with enthusiastic response

from participating optometrists. The courses give a maximum of practical material useful in practice: theory is kept to a minimum. Interested optometric groups should write to the College of Optometry, University of Houston, Houston 4, Texas, for course descriptions and to make arrangements as to dates for a course.

NEILL TO SPEAK AT SOUTHWESTERN CONTACT LENS CONGRESS

Dr. John Collins Neill, professor of optometry at Pennsylvania State College of Optometry, will be the principal speaker at the Second Southwestern Contact Lens Congress scheduled to be held in Waco, Texas, next June.

Dr. Neill recently received the William F. Herschel gold medal award in Munich, Germany, for his outstanding work in the contact lens field.

Dr. Neill is rated among the top contact lens practitioners in the world and recently constructed a completely new micro lens. He is currently engaged in contact lens research at Pennsylvania State College of Optometry.

EMIL H. ARNOLD AWARD

Dr. Richard J. Ball of Owosso, Michigan, has been awarded the first fellowship for graduate study in Optometry and Physiological Optics at The Ohio State University, provided by The Emil H. Arnold Optometric Scholarship Endowment Fund.

This award in the amount of $1,800 for the 1957-1958 school year represents a part of the accrued income from the principal invested by Dr. Emil H. Arnold of Ann Arbor, Michigan, for optometric scholarships at The Ohio State University School of Optometry.

MASSACHUSETTS COLLEGE AWARDS

Dr. Joseph F. Montminy, president of the board of trustees of the Massachusetts College of Optometry, has announced that Norman K. Varnum, of Calais, Maine, a transfer student from the University of Maine, has been chosen to receive the Theodore F. Klein Memorial Award of $200 given by the trustees annually to that student making the highest average in all the courses of the first year curriculum.

Representing the faculty committee on awards, headed by Dr. Frederick E. Farnum, Dean Ralph H. Green made the award and read the citation during the Northeast Optometric Congress being held in Boston. Dr. Montminy also announced recently that Marvin Greenberger, of Providence, Rhode Island, a transfer student from the University of Rhode Island, had been selected by the faculty committee on admissions, headed by Dr. Foster Namias, to receive the Maurice H.

Saval Scholarship. Mr. Greenberger will receive a scholarship of $300 this year and is eligible to receive $300 more next year if he ranks in the upper third of his class at the completion of the first year curriculum.

A. O. TRAVELING EXHIBIT OF EYEWEAR

A traveling display of the entire American Optical eyewear line had its first showing at the Carter Hotel in Cleveland on October 9-11. Professional people attended by invitation and were given time to peruse the line individually and discuss their needs with company representatives. The newest styles available in the region were on display, and the reception was enthusiastic.

HOUSTON FACULTY MEMBER SPEAKS IN MEXICO

Dr. Bernard Mazow recently presented a paper on *Optical Aids in Subnormal Vision* in Mexico City. His appearance was sponsored by the Mexican-North American Cultural Institute, the Eye Research Foundation, and the Centro Editorial Braille, all of Mexico City. In attendance were optometrists, ophthalmologists, and other professional workers interested in problems of blind and partially sighted people.

Dr. Mazow practices optometry in Houston, Texas. He is chairman of the Section on Contact Lenses and Subnormal Vision of the American Academy of Optometry and also is lecturer on Contact Lenses at the University of Houston College of Optometry.

ILLINOIS COLLEGE OF OPTOMETRY—GIFTS AND AWARDS

The receipt of an additional donation of $1,000 from Dr. Newton K. Wesley and Dr. George N. Jessen of Chicago to supplement the Wesley-Jessen Student Loan Fund has been announced by Dr. E. W. Strawn, president of Illinois College of Optometry. This fund, originally of $2,000, was established in 1956 by Wesley and Jessen to assist undergraduates in financial emergencies. In thanking the donors, Dr. Strawn stated that during the past year ten students have borrowed varying sums from the Fund, and that in some cases this financial assistance meant the difference between dropping out of school and continuing with their undergraduate education.

Dr. Frederick R. Kushner, Sheldon, Iowa, national ICO Alumni Association president, presented the annual Alumni cash awards of $75 each to four students at the assembly held on October 11th, at the college. Recipients of the awards were: Messrs. H. William Wassink, Wisconsin, and Lawrence Y. Yamamoto, Hawaii, third year students; and Joseph F. Ryan, Illinois, and Donald P. Cohen, Ohio, second year students. The awards are based on academic achievement, leadership ability and service to the school.

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CHARLES SHEARD, Ph.D., M.A., Sc.D.

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> *"To honor the technical scholarship of Charles Sheard, professor of Biophysics at the Mayo Foundation and recipient of several medals for distinguished service in the field of optics, this volume reprints a few examples of his many books and articles in the area of ophthalmological and optometrical sciences. The highly technical text studies astigmatism; prisms; skiametry; bifocal, trifocal, and contact lenses; nonphotophobic individuals; illumination and vision; tolerance of light, and related topics. There are many . . . tables, statistics, formulas, and case histories. The appended bibliography lists of 298 items written by Dr. Sheard in standard optical and medical journals, in textbooks and in brochures."* – Books from the U.S.A.

Dr. Sheard was formerly editor of the *American Journal of Physiological Optics* and for many years director of the Department of Biophysics, The Mayo Foundation. The book contains 83 illustrations, 476 pages, $15.00.

CONTENTS

SECTION ONE – Selections from Editorials and Short Essays. SECTION TWO – Dynamic Ocular Tests. SECTION THREE – Dynamic Skiametry and Methods of Testing the Accommodation and Convergence of the Eyes. SECTION FOUR – Considerations Regarding the Analysis and Interpretation of Data on Ocular Accommodation and Convergence; Zones of Ocular Comfort. SECTION FIVE – Ophthalmic Optics with Applications to Physiological Optics. SECTION SIX – Ocular Photosensitivity and Dark Adaptation. SECTION SEVEN – Personalia.

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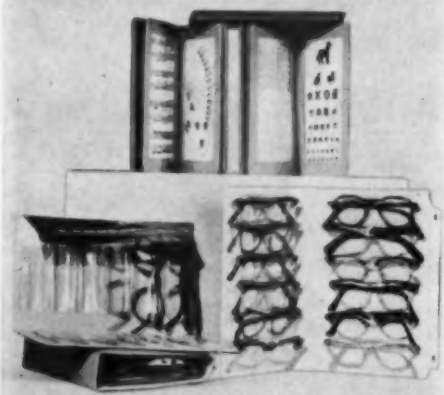

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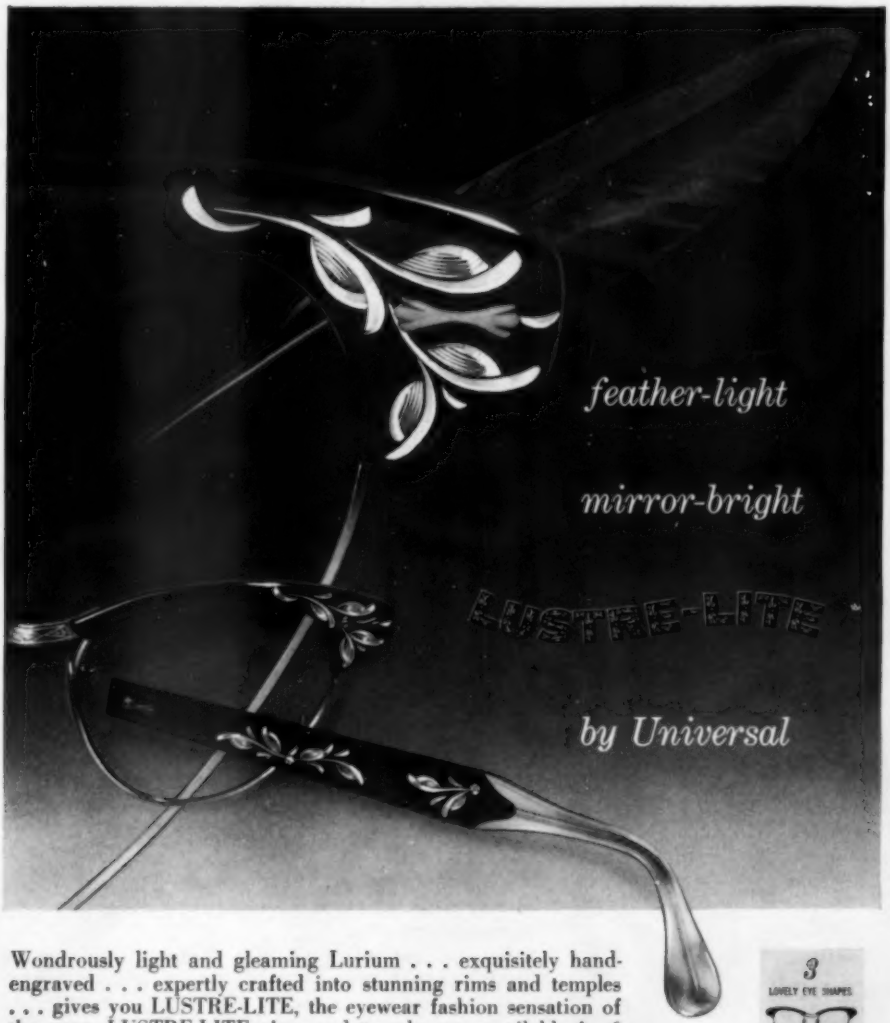

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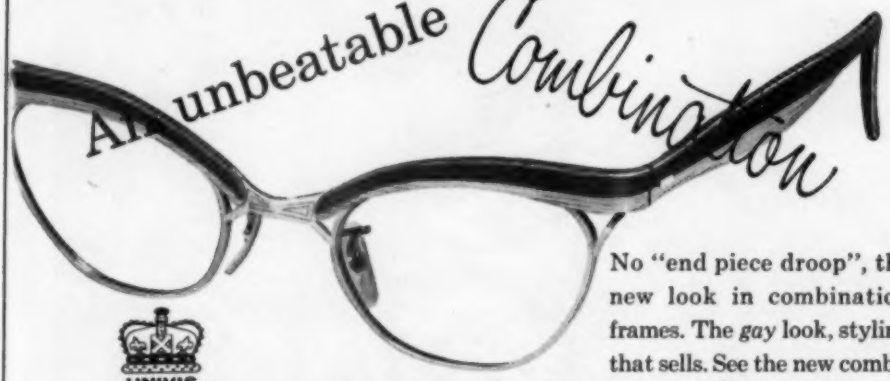

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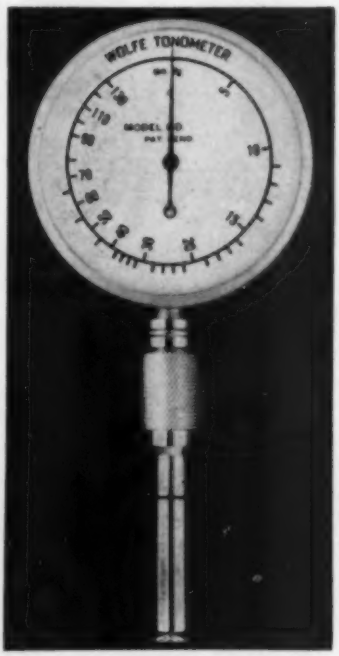

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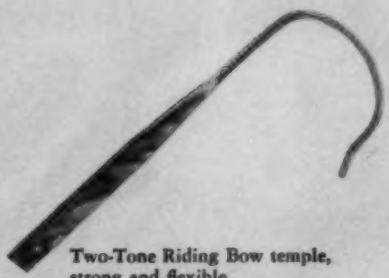

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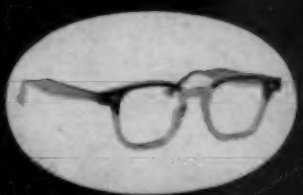

Style One: Man's clear bridge zyl frame, pennant shape, with aluminum temple. (Pictured at left) **Colors:** Black Bark, Red Bark and Mocha on Crystal.

Style Two: Clear frame with zyl temple. Same colors as above.

Style Three: Solid colors with aluminum temples. **Colors:** Black Bark, Red Bark and Mocha.

Style Four: Solid colors with wide all zyl skull temple. (As pictured at right.)

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